Appendix G

HEC-5 INPUT DESCRIPTION

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G.1 Introduction

The preceding Table of Contents for this appendix lists all HEC-5 records. Also included at the end of the table of contents is the Functional Use Index. This index can be used to determine which input variables are required for specific tasks. This document provides a detailed description of each variable in each input record. The Summary of Input Records located on the inside back cover shows the sequential arrangement of records. It also serves as a "table of contents" by showing the page numbers where the records are described throughout this appendix.

G.1.1 Input Format

An input file is a series of input records based on an 80-character card-image. Each record is defined by the identification (ID) placed in the first two columns. The input descriptions that follow have the record ID in the header for easy reference. Blank lines (records) in an input file are acceptable.

Variable locations for each input record are shown by field number. The records are normally divided into ten fields of eight columns each except Field 1. Variables occurring in Field 1 may normally only occupy columns 3-8 since columns 1 and 2 are reserved for the required record identification characters. The different values a variable may assume and the conditions for each are described for each variable. Some variables simply indicate whether a program option is to be used or not by using numbers such as -1, 0, 1. Other variables contain numbers which express the variable magnitude. For these a + or - sign is shown in the description under "value" and the numerical value of the variable is entered as input. Where the variable value is to be zero, the variable may be left blank since a blank field is read as zero.

If decimal points are not provided in the data, all numbers must be right justified in the field. Any number without a sign is considered positive.

Locations of variables on input records are sometimes referred to by an abbreviated designation, such as J1.4 representing the fourth field of the J1 Record.

G.1.2 Related Programs

The use of the Hydrologic Engineering Center's data storage system (HEC-DSS) for the specification of time series data is described in Section 11, "Specifications for Time Series Data Records", following the input description for the ED Record.

Four other programs (CKHEC5, MOD5, INFIVE and COED) are also available to use with HEC-5. The CKHEC5 program is a comprehensive input data checking program that performs essentially all of the checks that are possible given the knowledge of the problem furnished by the input data. The MOD5 program is an interactive program designed to facilitate input modifications to an existing HEC-5 data file.

The INFIVE program is an interactive program designed to generate an HEC-5 input file containing the input records required to perform any job described by the user through a series of questions and answers. The COED (the Corps of Engineers Editor) program provides special help information for HEC-5 input records.

G.2 Documentation Records

G.2.1 T1, T2, T3 Records - Job Title Records (required)

Three records are required. Both alphabetic and numeric information may be placed on these records. Information on these records will normally be printed out as a job title on the first page of the output. Columns 17-26 of the T1 Record will be used as site identification code for the optimization conservation summary (*OPSUM).

G.2.2 C_ Records - Comment Records (optional)

Optional comment records (C in Column 1 and blank in Column 2) can be used to provide documentation of the input data. The comment record is printed along with the input listing.

G.3 Job Control Records

G.3.1 J1 Record - Storage Allocation and Units (required)

Field	Variable	Value	Description
			Units of Input Data and Output
1	METRIC	1	All input and output are in **metric** (SI) units.
		0	All input and output are in **English** units.
			Monthly Data
2	ISTMO	0-1	The first value of **monthly data records**, within T1-ED portion of an HEC-5 data set, represents **January** data. Monthly data records related to this option are: J6, SM, RL, R3, PR, QD, CC, and QM.
		2-12	Not recommended.
			Reservoir Storage Levels
3	NUMLEV	2-40	Number of **reservoir storage levels** for each reservoir of data set. *Typical data sets may specify 5 levels with level 1=inactive storage; level 2=buffer storage; level 3=top of conservation storage; level 4=top of flood control storage; and level 5=top of dam or top of surcharge storage.*
4	LEVCON	2-39	Level number which corresponds to the **top of the conservation** (water supply-hydropower) storage pool on **RL Records.** *Typically=3*.
5	LEVTFC	2-40	Level number which corresponds to the **top of the flood** storage pool on **RL Records**. *Typically=4*.
6	LEVBUF	2-39	Level number which corresponds to the **top of buffer** (drought contingency) storage pool on **RL Records**. When storage is above this level, minimum desired and hydropower releases will be made. Below this level, only minimum required releases will be made. *Typically=2.*

Field	Variable	Value	Description
			Hydropower and Diversion Options
7	LEVPUM	0	Top of conservation storage level (LEVCON) will be used for top of **pump-back pool** when diversion options -3 or -4 are used. See DR.7
		2-39	Level number used for top of pump-back pool. Must conform to the following: LEVBUF ≤ LEVPUM ≤ LEVCON.
8	NOADLV	0	Reservoir levels will be increased internally in the program from NUMLEV to KLEV (typically 40) for better accuracy for system power and monthly computations. However, no increase will be made if no power systems are used and time interval is less than monthly.
		10	Reservoir levels will not be increased beyond the input value NUMLEV, and no interpolation of seasonal (monthly) levels will be made for daily routings.
		-	**Number of levels** to be added between Level 1 and LEVBUF (when LEVBUF = 2).
9	LEVPRC	0	Power rule curve will be assumed to be the same as top of buffer pool (LEVBUF). Program can add levels for added accuracy (see J1.8).
		+	Reservoir index level for power rule curve operation of power projects. Above this level (based on previous time period), the project will operate for at site energy (based on either PC vs. PF Records or PR Records only) times the PRCRAT factor (PR.14). Below this level the project will operate for at site energy (assuming PRCRAT=1) if at-site power priority (J2.4=2) is requested. In order to add levels for increased accuracy (see J1.8) this value must be equal to **LEVBUF**.
10			Not used.

G.3.2 J2 Record - Operational Parameters (optional)

Field	Variable	Value	Description
1	IFCAST[1]	0	Twenty-four **hours** of foresight will be used by the program to determine reservoir releases in the system operation when IPER is equal or greater than one hour. When IPER(BF.7) is less than one hour, 4 periods will be used. Value used should represent ability to forecast flows with CFLOD (J2.2) accuracy.
		+	**Number of hours** of foresight on inflows and local flows to be used in system operation for all reservoirs unless different values are specified on R2 Records (R2.5). If IPER(BF.7) is less than 1 hour, specify minutes using a decimal (i.e., use .30 for 30 minutes of foresight).
2	CFLOD	0-1	Constant is assumed = 1.0. (CKHEC5 program will give warning message.)
		1+	**Coefficient greater than or equal to one by** which local flows are temporarily multiplied as a contingency allowance in the determination of reservoir releases. If this value is 1.2, a 20% forecasting error is assumed for IFCAST hours. This 20% error will be used for both flood control and conservation releases. A value of 1.2 is typically used for flood control planning. For "Real-time" water control applications, a value of 1.0 is typically used.
3	RATCHG[1]	0	The maximum rate of change during a **one hour** time period for all reservoir releases will be assumed to be .04 times the designated channel capacity (CP.2 or CC Records) unless specified differently on R2 Records for specific reservoirs.
		+	The maximum rate of change of all reservoir releases during a **one hour** time period expressed as a ratio of the channel capacity (CP.2 or CC Records) unless specified differently on R2 Records for specific reservoirs.

[1]These variables are ignored for weekly or longer (BF.7) time intervals.

Field	Variable	Value	Description
4	IPRIO	0-127	The **sum** of the following codes that represent the desired priorities in the operation is used for IPRIO.

Code[2]	
0	Normal priorities will be made as indicated below by criteria in parenthesis.
1	When **flooding** is occurring at a downstream location, primary **power releases** will be made at upstream reservoirs (*instead of curtailing the power releases*).
2	Primary **at site power releases** will be made as long as the reservoir storage level is above Level 1 (*instead of top of buffer level*).
4	All specified **diversions from reservoirs** will be made as long as the reservoir is above Level 1 (*instead of top of buffer pool*) except when diversions are a function of reservoir storage.
8	When **flooding** is occurring at a downstream location, **minimum** (desired Q, required Q) **flow releases** will be made, which contributes to the flooding (*instead of making no releases*).
16	When **balancing** an upstream tandem reservoir with a downstream tandem reservoir, the **equivalent level** of the system is used *(instead of downstream reservoir level*) for monthly simulations.
32	This code causes the program to **recycle through the solution process twice** (*instead of once*). This option can provide better simulation results for complicated water supply models involving shortages in minimum low flow demands. It is suggested that this option be applied only when water supply simulation results are unsatisfactory producing reservoir release error messages.
64	**System power** releases will be made as long as the reservoir storage level is above Level 1 (*instead of top of buffer level*).
128	**Tandem** reservoir operation will be curtailed at top of buffer level *(instead of Level 1)*.

[2]If any of the codes (1-64) are not selected, operational priority for that item will be based on normal priority as shown in parenthesis.

Field	Variable	Value	Description
5	IOPMD[3]	0	Reservoir releases will be made equal to inflow above top of flood control pool up to outlet capacity, at reservoirs without gate regulation curve data (RG Record).
		1	Same as above except that **pre-releases** equal to channel capacity at the dam site will be made as soon as it can be determined that the reservoir will exceed the flood control storage using IFCAST (J2.1 or R2.5).
		2	Same as 1 except **pre-releases** can be larger or smaller than channel capacity. Constant releases are determined for future periods so that the top of the flood control pool will just be reached within the forecast period, IFCAST (J2.1 or R2.5).
6	ISCHED	0	Do not use scheduling ("0" is typically used).
		1[4]	Use scheduling. No releases will be made from a reservoir unless all higher priority reservoirs in parallel are also releasing. The sum of the releases from all upstream reservoirs during any time period is not allowed to exceed damaging channel capacity at any downstream control point.
		10	Reservoir releases are calculated assuming future releases are the same as the current periods release. This option may reduce large fluctuations in reservoir release.
7	NCPTR	0	All control points will be used in the system.
		+	Identification number of last control point to be used in this run of the system. Option is used to operate a sub-system when data is for a large system. The total number of control points can exceed the dimension limits (KNCPT) as long as subsystem specified does not. The first RL Record should be for the upstream starting point. **NCPTR must be a non-reservoir.**
8	NCYCLE	0-1	When recycle option is specified (J2.4 Sum Includes 32), HEC-5 will cycle through the solution process one more time.
		2-10	When recycle option is specified, HEC-5 will cycle through the solution process 2-10 additional times.
9-10			Not used.

[3] If gate regulation curve option is used (RG Records) the pre-release option will not be applied to that reservoir.

[4] This option is used only if there is a problem in emptying an upstream reservoir which is located many times the travel time to the damage center as other reservoirs.

G.3.3 J3 Record - Output and Flow Options (required)

A continuous listing of all input data record images, including flow, will be made for all jobs stacked together (up to 10,000 lines) unless a "NOLIST" in record columns 1-6 is present. A single "NOLIST" record placed in the data file will terminate the remainder of the data record listing. A series of NOLIST and LIST records can be used to suppress printout of data between the two records.

Each type of output has a label on the left side of the page to make it easier to locate with an interactive text editor. The program labels are shown below.

	Output Label	Output Type
(HEC-5A Output)	*Input	Summary of input data
	*FLOWS	Formatted table of flow data
	*Rule	Summary of reservoir storage levels (Rule Curve)
	*Operation	Summary of locations that are operated for
	*Map	Two schematic maps showing reservoir operation locations and summary information
	*Reservoir	Summary of reservoir data
	*Routing	Operating control points
	*LOCFL	Computation of incremental local flows
	*OPTRY	Optimization results for each try
	*OPSUM	Summary of final optimization results
(HEC5B Output)	*FLOOD n	Start of HEC5B output for flood number "n"
	*NORML	Normal sequential output
	*ROPER	Reservoir data by period
	*PLOTS	Plotted hydrograph
	*SUMF1	Single flood summary
	*SUMFS	Summary for all flood events
	*SUMPO	Summary for conservation operation
	*ECDAM	Economic data and damage computation
	*EPLOT	Flood frequency plots
	*ESUMD	Summary of expected annual damages
	*ESUMC	Summary of system costs
	*ESUMB	System economic cost and performance
	*HYEFF	Hydrologic efficiencies
(Output from HEC-5A/ HEC-5B)[1]	*USER5A	User designed output (J8 and JZ Records) from HEC-5A
	*USERS	User designed output (J8 and JZ Records) from HEC-5B
	*RRPER	Reservoir releases by period
	*RQPER	Control point regulated flow by period
	*DVPER	Diversions by period
	*DVSHORT	Diversion shortages by period
	*FCPCT	Percent flood control storage used
	*ERROR	Output error check
	*CASES	Listing of case definitions (“reasons” for reservoir release)

[1] See J3.9 to select output source.

Field	Variable	Value	Description
1	PRINT	0-511	The **sum** of the following codes that represent the desired output (in addition to J8 Record output) is used for PRINT.

Code	Option
0	All output listed below.
1	Single flood summary of maximums for reservoirs and control points (where time interval (IPER, BF.7) is DAILY or less) for each flood event.
2	Summary of maximum and minimum values for each event and for all events. Also summary of monthly operations and system energy. (*SUMFS, *SUMPO)
4	Output error check **(should always be requested)**. (*ERROR)
8	Normal sequential output by control point, by variable and by time period. Should only be requested for short flood events due to excessive output. (*NORML)
16	Reservoir data by period (all floods). (*ROPER)
32	Reservoir releases and control point regulated flows, percent flood control storage used, and diversions and diversion shortages, by time period (all floods). The time window on the J8 Record also applies to this output. (*RRPER, *RQPER, *DVPER, *DVSHORT, *FCPCT)
64	Computation of incremental local flows from natural or observed conditions. (*LOCFL)
128	Flow records. (*FLOWS)
256	Hydrologic efficiencies (*HYEFF)

2	PRCOL		This option is no longer used.

Field	Variable	Value	Description
3	IPLOTJ		This option is no longer used.
4	FLONAT	0	**Natural** or unregulated flows, that is, flows that would have existed if no reservoirs were upstream, will **not** be **computed**. However, they can be read on NQ Records. If ILOCAL = 20(J3.6), natural flows will be calculated and printed from the IN Record data.
		-1	**Natural flows will be calculated** (omit NQ Records). If ILOCAL (J3.6) = 20, natural flows will be based on adjusted computed local flows (no negative locals).
5	CRITPR		This option is no longer used.
6	ILOCAL		**IMPORTANT:** See next page for description.

SPECIFICATION OF INCREMENTAL LOCAL FLOWS:

This is the single most important input item in an HEC-5 data set. ILOCAL, J3.6, defines the type of flow data (natural, observed, or incremental local flow) entered on "IN" data records within the time series data set (BF through EJ Records). HEC-5 requires a consistent flow data set for a specified period of analysis. This means that a mixture of flow data types, for instance, 5 years of natural (unregulated) flows followed by 10 years of observed (regulated) flows is not valid in a single simulation.

"Incremental local flows" are discharge hydrographs which enter a stream system between adjacent control points. The value of ILOCAL indicates whether incremental local flow data are to be computed from **"natural"** or **"observed"** flow data or **read-in directly**.

A **negative value** for ILOCAL will allow the use and computation of negative local flows. A **positive value** for ILOCAL causes negative local flows to be set to zero. Negative flow volumes will be redistributed within the hydrograph (thus maintaining the proper volume) when flow computations are made with positive ILOCAL values.

HEC-5 may be used to develop a consistent database of local incremental flows from observed or natural flow data by indicating ILOCAL=±15 (observed flows and releases) or ILOCAL=±20 (natural flows) and writing the computed incremental local flows to HEC-DSS for subsequent use with ILOCAL=±1.

For **real-time water control** simulations using ILOCAL=±5 the following should be added to the HEC-5A execution line: **QLOCINC=filename**. Where "filename" is the name specified during the first computation of local flows for the particular forecast time.

Field	Variable	Value	Description
6	ILOCAL	±1	Direct input of **incremental local** flow data in time series data (IN Records).
		±20	Compute incremental local flows from **natural** flow (IN Records).
		±15	Compute incremental local flows from **observed regulated flows** (IN Records) and **corresponding observed reservoir releases** (QA Records[1]).
		±5	**Real-time water control** option to compute incremental local flows from IN and QA Records (same as =±15) while writing the computed local flows to a binary file for subsequent access during re-simulations.

[1] When computing incremental local flows using QA Records, the reservoir release values must be INTEGER values since decimal values would be interpreted as "release codes" and local flows cannot be calculated when reservoir release codes are used (i.e., do not use codes .001, .22, .24, etc.)

Field	Variable	Value	Description
7	NOROUT	0	Indicator is assumed equal to 24 hours. Channel routing and forecasting will not be made if IPER (BF.7) is greater than NOROUT.
		+	Indicator used to differentiate between short interval operation that would use routing and forecasting IFCAST (J2.1 or R2.5) and long interval conservation operation in which routing and forecasting would not be used.
8	INTYPE	0	Input flow data are average for the period.
		1	Input flow data are end-of-period on IN and NQ Records. QA and MR Records are average values. Program will average flow data.
		5	Input flow data are end-of-period on IN, NQ, and QA Records. MR Records are average values. Program will average flow data.
9	NOOPTS[2]	0	Program HEC-5B should be executed.
		1	Data will NOT be written from the simulation program HEC-5A that is required for the output program HEC-5B to execute. Therefore, job control should execute HEC-5A only and NOT HEC-5B. If J8 Records are input, all user designed output will be displayed from program HEC-5A (except for hydropower peaking capability) along with regulated flows, etc. (J3.1=32).
10			Not used.

[2] Using this option will limit certain capabilities of the program (i.e., no normal sequential output; no multiple floods; no damage calculations; no frequency plots; etc.), since program HEC-5B performs these functions. However, this option can save substantial clock time for a large system of reservoirs.

G.3.4 J4 Record - Benefit/Cost Data (optional)

Field	Variable	Value	Description
1	IANDAM	0	No flood damages will be computed.
		-1	Damages for each individual flood operated by the system will be determined using data from the DA-DC Records (expected annual damages will not be estimated).
		1	Expected annual damages will be calculated for natural conditions, for uncontrolled local flows, and for regulated conditions. The probability for each regulated flood will be assumed equal to the probability of the natural event.
		2-100	Expected annual damages will be calculated for the same three conditions as above. Probabilities for regulated conditions will be based on rearranging the flood events at each control point in the order of magnitude and assigning plotting positions based on IANDAM **years of record**. This option should be used when both monthly and short-interval routings are made.
2	ECFCT	0	No damage data will be used (records DA-DC omitted) or factor "ECFCT" will be assumed = 1.
		+	Factor to be multiplied times all damage data on the DC Record.
3	IPRECN	0	**All** types of economic output will be printed including frequency plot.
		-1	All economic output printed **except** frequency plot.
		1	Economic summary table **(only)** will be printed.
		2	Economic summary table and summary by category **(only)** will be printed.
4	BCRFAC	0	Capital recovery factor, if used, will be specified on the CP Record.
		+	Capital recovery factor (used when data is omitted from first field of C1 Record) which is multiplied by the present worth of reservoir or control point costs (R$ or C$ Records) to obtain the annual cost of the capital investment based on desired interest rate.
5	COSFAC	0	Any cost data will be multiplied by 1.0.
		+	Cost data on records R$ and C$ will be multiplied by COSFAC.

Field	Variable	Value	Description
6	PCVAL	0	Peak power capacity benefits are not to be calculated.
		+	Peak power capacity benefit value in dollars per kW.
7	PEPVAL	0	Primary power benefits are not to be calculated.
		+	Benefits for primary energy in dollars per 1000 kWh (=mills/kWh).
8	PESVAL	0	Secondary power benefits are not to be calculated.
		+	Benefits for secondary energy in dollars per 1000 kWh (=mills/kWh).
9	PEBVAL	0	No penalty will be assessed for power shortages.
		+	A penalty for power shortages in dollars/1000 kWh. Cost to purchase power on open market would be good penalty value.
10	J410[1]	0	Flow-exceedance frequency curve is not written to HEC-DSS.
		1	Flow-exceedance frequency curve is written to HEC-DSS for those locations when damage computations are requested. Exceedance frequency is written as a PROBABILITY (a ZW Record must also be used).
		2	Same as 1, except exceedance frequency is written as a PERCENTAGE (probability x 100).

[1] HEC-5B should be executed if J4.10 = 1 or = 2.

G.3.5 J5 Record - Reservoirs Deleted (optional)

Field	Variable	Value	Description
1	NRDEL	+	Number of reservoir identification numbers to be read on J5 Records starting in Field 2. Maximum of 29. Sets of J5 Records (corresponding to the number of values on FC Record) can be used to describe reservoirs to be deleted for each flood ratio used.
2+	RESDEL(I)	+	Reservoir identification number (same as Field 1 of RL Record) of all reservoirs which are to be operated with outflows equal to inflows instead of using the criteria shown on records RL-RQ. The program will automatically change the storages on the RL Record to zero, will eliminate the downstream control points the reservoir was to have operated for on RO Record, and will change the outlet capacities on RQ Record to 1,000,000 m^3/s (ft^3/s). RO Record must be manually changed if an upstream reservoir operates for the deleted reservoir (see RO.2), or records RL-RQ for the upstream reservoir must be removed.

G.3.6 J6 Record - Basin Monthly Evaporation (optional)[1]

Field	Variable	Value	Description
1-12	EVRAT(K)	+,-	Net evaporation (evaporation minus precipitation rate) in millimeters (inches) per month over the reservoir area for 12 periods starting with January (J1.2). Reservoir areas (1000 m^2 or acres) are input on RA Record. These evaporation rates may be multiplied by Field 3 of each R2 Record. Rates for each reservoir can also be read on R3 or EV Records.

[1] If J6 Record is used, two J6 Records are required.

G.3.7 J7 Record - Conservation Optimization (optional)

Field	Variable	Value	Description
1-4	OPTCON	0	No control points will be optimized.
		+	Reservoir locations (up to 4 which are not in tandem with each other) where conservation storage or reservoir yields are to be optimized. A determination can be made of the minimum conservation storage required (between level LEVBUF and level LEVCON on RL Record) to satisfy the input demands (including minimum flows, diversions and installed power capacity) through the flow period shown on IN Records.[1] To optimize one of the yields of this reservoir using the input conservation storage on the RL Records, one of the codes .1-.6 or .9 is added to the control point number (e.g., 15.1 would optimize power requirements for Reservoir 15). All other demands will be used as specified on input records.

Code

.0 = **optimize conservation storage** above top of buffer pool (LEVBUF, J1.6).

.1[2] = **optimize the monthly power requirements** (expressed as monthly plant factors on the PR Record) **and the installed capacity of the power plant** (assuming average PR Record plant factor) based on top of buffer unless priority is requested for Level 1 (J2.4=2).

.2 = **optimize the minimum desired flow** (CP.3 or QM or MR) Records based on top of buffer pool.

.3 = **optimize the minimum required flow** on CP Record based on Level 1.

.4 = **optimize the diversion schedule** on QD Records based on top of buffer level (Level 1 if priority is requested (J2.4=4).

.5 = **optimize the monthly plant factors** (PR Record) based on either top of buffer or Level 1 (J2.4=2) but do not change the installed capacity. This option is normally used to determine firm energy for the existing installed capacity.

Continued on next page

[1] See J7.8 to limit flow data. Flow data must be incremental flows (J3.6=±1). Flows can be monthly or weekly. Daily flows are allowed if the time period dimension limits (KPER) are large enough for the critical period. Columns 17-26 of T1 Record is used for site title on optimization results (*OPSUM).

[2] This option (rather than .5) is normally used when no power plant exists or when the installed capacity might be increased.

Field	Variable	Value	Description
			Code - *continued*
			.6 = **optimize diversions based on water rights priority** (WR Record). Intended for use with a year's worth of daily data. Set OPTERR=.99 (J7.10).
			.9 = **optimize yields for codes .1-.4** based on level 1 using fixed ratios between demands as specified on input data.
5	IDSLOC	0	Optimization of yield will be accomplished on reservoir being optimized.
		+	**Downstream control point location** where yield is to be optimized.
6			Not used.
7	IOPTY1	0	The program will determine the initial estimate of the installed capacity.
		1	The first routing will use the installed capacity of the project from the second field of the P1 Record.
8	CRITPR	0	Operation of reservoirs is simulated for all time periods shown on IN Records.
Recommended Selection		1 or 2	CRITPR is assumed to be equal to 70 times "RAPSQ", which is the ratio of conservation storage to mean annual flow (up to 175 months). The critical drawdown for .3 ratio of conservation storage to mean annual flow would be 21 months. Operation of system is then limited to critical period plus few periods on each end of the critical period. A value of 2 (instead of 1) will provide a table of starting and ending periods for durations from 1 to 60 periods.
		3+	Perform routing for CRITPR periods. Define "CRITPR" as length (periods) of critical drawdown by finding beginning and ending periods corresponding to the minimum flow volume for duration = CRITPR.
		-X.Y	Data grouped by time periods on IN Records, etc., are shifted and reduced so that the first data item is for time period X and the last data item is for time period Y. Operation of system is limited to periods X through Y. A value of -32.064 will use periods from 32 to 64.
9	IFLAG	0,1	Optimize for period of record (critical period only if J7.8.GT.0), then stop.

Field	Variable	Value	Description
Recommended Selection		6	a. Optimize for critical period first (J7.8 must not equal zero), and IN Records must be for period of record), then b. Check above results by routing period of record (once) and c. Stop if drawdown error is less than OPTERR (J7.10); otherwise, optimize using new critical period from step b, then d. Check above results using period of record and e. Stop if drawdown error is less than OPTERR (J7.10); otherwise, optimize using new critical period from step b, then f. Check above results using period of record and g. Stop.
10	OPTERR	+X.Y	Allowable errors between target minimum conservation storage (Level 1 or LEVBUF) and minimum storage obtained in routing. Value (X) to left of decimal indicates allowable **negative** error (causes shortages in yield because drawdown is too great) in **1000 m^3** for metric (acre-feet for English). Value to right of decimal indicates the allowable **positive** error expressed as a **ratio**. A 100.01 indicates that a negative error of 100 acre-feet would be allowed and that a 1% positive error would be acceptable.
Recommended Selection = 0.01		+.Y	If value to left of decimal is zero, then the allowable negative error is the same percentage error as the positive error (a 0.01 would represent a 1% allowable error for both positive and negative).
		+.99	Program will **accept any error** in drawdown storage. Therefore the J7 Record can be used to simply provide special power output rather than an optimization (J7.1 must also be used). This option can be used with R1 and FC Records to allow multiple user determined hydropower capacity estimates.
		-	**Same as** any of the **above** options except that one additional routing will be made after optimization has been found in order to get correct reservoir levels (optimization routine adds 500,000 AF storage) and shortages (except for power, no shortages are allowed in optimization runs) for final printout.
		0	Same as +X.Y option except that a 100 acre-ft negative error and a 1% positive error are assumed.

G.3.8 J8 Record - User Designed Output Format (optional)

Optional record used to define output tables. Each **record** used will specify output variables to be printed for up to 10 columns. Three types of user defined output can be specified by J8 Records. A time window to specify time periods to be printed (for output types 1 or 2) for one or more J8 Records can be specified on any J8 Record. The starting and ending time periods are shown in fields 1 and 2 of the J8 Record with the rest of the record blank.

User Defined Output Type[1]

1 **Data by Period (first field is positive) CP.VAR**

Each **field** of the record used should contain the control point **location** (to the left of the decimal) and variable **code** (to the right of the decimal). For example, a 77.10, 88.10, 77.12, 88.12, 77.13, 88.13 in fields of 1-6 would print six vertical columns for each period of the routing showing in order: for reservoirs 77 and 88 the outflows (code 10=outflow), cases (code 12=cases), and levels (code 13=level). Add .009 if output should be converted from ft^3/s to acre-feet (i.e., 88.109 for reservoir 88 outflow, in acre-feet).

2 **Summary Data by Control Point (first field is negative) TYPE.VAR**

Each record field for this output type is printed in a column for all control points along side a schematic map of the system. When regulated flows are requested (code = .04), both reservoir releases and non-reservoir regulated flows are shown. Regulated flows are also shown for non-reservoir locations when reservoir inflows or outflows are requested.

Each **field** of the record (up to 6 can be used for most schematics) should contain the code for the math function of the variable (to the left of the decimal) and the variable code (to the right of the decimal). Codes for the math function are: 1 = sum, 2 = maximum, 3 = minimum, 4 = period number of maximum, 5 = average. A math **code of 6** or greater is used to specify the **time period** for the output variable corresponding to the variable code specified. For example a J8 - 2.02 2.04 2.0 10.04 11.04 12.04 would show the maximum natural, maximum regulated, difference between the two, and the regulated flows for time periods 10-12. If a single variable is requested on a record, then two schematic maps are drawn beside each other. The first map contains the location numbers and the second shows the output variable.

3 **Annual Data - (first field is positive) CP.VAR + CODE**

Each field of the record used should contain the control point location (to the left of the decimal) and the variable code (to the right of the decimal). In addition, a value of .001, .002, .003, or .004 is added to the number to obtain the annual maximum, annual minimum, annual average, or annual sum, respectively. For example, a 2.031 would request annual maximum data for location 2 for variable 3 (which are diversions).

[1] All three output types are available from the second half of the program, HEC-5B, plus output Type 1 is also available from HEC-5A. In order to get this output from HEC-5A, J3.9 must equal one (1) to suppress HEC-5B output. This option greatly enhances execution times for large systems. See J3.9 description for further information.

Variable Code	Description	Variable Code	Description
	Reservoirs ONLY		
.09	Inflow	.12	Case
.10	Outflow	.13	Level
.36	Gate Regulation Release	.14	Equivalent Level[2]
.11	Storage	.21	Evaporation
.37	% of "Normal" Storage[1]	.22	Elevation
.38	Top of Conservation (Storage)	.41	Top of Conservation (Elevation)[3]
	Power Reservoirs ONLY		**Power Systems ONLY**
.15	Required Energy (at site)	.26	System Energy Required[6]
.16	Generated Energy (at site)	.28	System Energy Generated
.23	Energy Shortage (at site)	.29	System Energy Shortage
.25	Power Capability[4]	.27	System Energy Usable
.32	Power Spillage	.40	System Power-% Power Storage[6, 7]
.33	Power Head	.39	System Power-Monthly Plant Factors[6, 7]
.35	Power Plant Factor		
.34	Energy Benefit Rate (mills/kWh)[5]		
	Reservoirs and Non-Reservoir Control Points		
.01	Cumulative Local Flow	.03	Diversion (Flow)
.02	Natural Flow	.30	Diversion Requirement (Flow)
.24	Incremental Local Flow	.31	Diversion Shortage (Flow)
.05	Minimum Desired Flow	.06	Shortage, Min Desired Flow
.07	Minimum Required Flow	.08	Shortage, Min Required Flow
.17	Channel Capacity (Flow)	.18	Q Space (Flow)
	Non-Reservoir Control Points ONLY		
.04	Regulated Flow	.19	U.S. Res/Div Flow
.20	Flooding Greater Than Local Flow		
	MATH FUNCTIONS		
X.00	Compute **difference** between the previous two columns of data (X is control point number)	X.99	Compute **sum** of previous **X** columns of data.
		.009	Add to flow variable to convert units from ft^3/s to acre-feet.

[1] When output for this variable is displayed, if the value is positive then it represents % *above* "Normal" pool; if the value is negative, then it represents % *below* "Normal" pool, where "Normal" = full conservation pool.

[2] For downstream tandem reservoirs only.

[3] This variable is available only from HEC-5A (see J3.9).

[4] This variable is available only from HEC-5B (see J3.9).

[5] Only if PC-PB Records are used.

[6] System energy variables are displayed for the first reservoir in the system.

[7] These variables are available if SC and SF Records are used but only from HEC-5A (see J3.9).

G.3.9 JZ Record - User Defined Output Variables for HEC-DSS (optional)

Optional record, used in conjunction with the ZW Record, to designate output variables to be stored in an HEC-DSS file. These records are used similar to the "Data by Period" type of J8 Records. The data are both written to DSS and printed (like J8 Records) unless the value for the first field of the first JZ Record is made negative, in which case data is only written to DSS.

If a JZ Record is omitted and a ZW Record is used, the default codes for regulated flow (.04) at all non-reservoir control points plus the inflow (.09), outflow (.10) and EOP storage (.11) for all reservoirs will be written to the HEC-DSS file.

		Data Units		
Variable Code	**"C part"**	**English Units**	**Metric Units**	**Data Type**
.01	FLOW-LOC CUM	CFS	m^3/sec	PER-AVER
.02	FLOW-NAT	CFS	m^3/sec	PER-AVER
.03	FLOW-DIV	CFS	m^3/sec	PER-AVER
.04	FLOW-REG	CFS	m^3/sec	PER-AVER
.05	FLOW-DESIRED	CFS	m^3/sec	PER-AVER
.06	FLOW-DES SHRT	CFS	m^3/sec	PER-AVER
.07	FLOW-REQUIRED	CFS	m^3/sec	PER-AVER
.08	FLOW-REQ SHRT	CFS	m^3/sec	PER-AVER
.09	FLOW-RES IN	CFS	m^3/sec	PER-AVER
.10	FLOW-RES OUT	CFS	m^3/sec	PER-AVER
.11	STOR-RES EOP	ACFT	1000s m^3	INST-VAL
.12	CASE-RES			PER-AVER
.13	LEVEL-RES			INST-VAL
.14	LEVEL-RES EQ			INST-VAL
.15	ENERGY-REQ	MWH	MWH	PER-CUM
.16	ENERGY-GEN	MWH	MWH	PER-CUM
.17	FLOW-CHAN CAP	CFS	m^3/sec	PER-AVER
.18	FLOW-Q SPACE	CFS	m^3/sec	PER-AVER
.19	FLOW-US RES	CFS	m^3/sec	PER-AVER
.20	FLOW-FLOOD RES	CFS	m^3/sec	PER-AVER
.21	EVAP-NET	CFS	m^3/sec	PER-CUM
.22	ELEV	FEET	METERS	INST-VAL
.23	ENERGY-SHRT	MWH	MWH	PER-CUM
.24	FLOW-LOC INC	CFS	m^3/sec	PER-AVER
.25	POWER CAPACITY	MW	MW	PER-AVER
.26	ENERGY-SYS REQ	MWH	MWH	PER-CUM
.27	ENERGY-SYS USE	MWH	MWH	PER-CUM
.28	ENERGY-SYS GEN	MWH	MWH	PER-CUM
.29	ENERGY-SYS SHRT	MWH	MWH	PER-CUM
.30	FLOW-DIV REQ	CFS	m^3/sec	PER-AVER
.31	FLOW-DIV SHRT	CFS	m^3/sec	PER-AVER
.32	FLOW-POWER SPILL	CFS	m^3/sec	PER-AVER
.33	HEAD-POWER	FEET	METERS	PER-AVER
.34	BEN RATE-ENERGY	MILL/kWH	MILL/kWH	PER-AVER
.35	PLANT FACT			PER-AVER
.36	FLOW-GATE REG	CFS	m^3/sec	PER-AVER
.37	PCT STORAGE NORM	PERCENT		INST-VAL
.38	TOP CON. STORAGE	ACFT	1000s m^3	INST-VAL
.41	TOP CON. ELEV	FEET	METERS	INST-VAL

G.3.10 JR Records - Clock Times for Reservoir Release Decisions (optional)

These records specify clock times when reservoir release decisions will be made by HEC-5 (all other computational periods, except the 1st computational time period, will repeat the previously calculated release). If these JR Records are omitted, or if they do not cover specific reservoirs or days of the week, or if the time interval is daily or greater, the program will default to compute releases for all time periods for those locations and days of the week. A maximum of 40 JR Records can be used to describe schedules for various locations and days of the week.

Field	Variable	Value	Description
1	LOC	0	All reservoirs will use the schedule specified on this record unless overridden by data on a subsequent JR Record.
		+	Reservoir location number (RL.1) that will use the clock schedule on this record.
2	IDAYST. IDAYED	X.Y	Starting (X) and ending (Y) day of the week for the schedule on this record (Sunday = 1). For example, use 2.6 for Monday through Friday on one record, and 7.1 for Saturday and Sunday on the next record.
3	CTIME	0	Release decisions will be made for all time periods (fields 4-10 are ignored).
		+	Clock time of the first release decision after midnight. For example use 1300 for 1:00 pm. Times must correspond to whole hours.
4-10	CODEJR	X.Y	Clock times (X) and optional code (Y) describing when release decisions will be made (other than the first decision). If Y is used, it represents the number of release decisions that will be made at intervals represented by the last two clock times. (Y can be from 0 to 9).

Example

```
JR  0   2.6    800    900.9
JR  0   7.7    700    800.4    1200    1400.4
JR  0   1.1    800     1000    1200      1400    1600
JR 10   2.2      0
```

The 0 in field 1 of the first three JR Records shows the first three schedules apply to all reservoirs in the system. However the fourth record shows an exception for reservoir 10 for Mondays.

The first JR Record shows that for Monday through Friday (2.6) of every week, 9 release decisions will be made per day at each hour of the day from 8:00 am to 4:00 pm. The second JR Record shows that all Saturdays (7.7) will have 4 release decisions at one hour intervals starting at 7:00 am (7:00 am, 8:00 am, 9:00 am, 10:00 am) followed by 4 release decisions at two hour intervals (12:00 noon, 2:00 pm, 4:00 pm and 6:00 pm). The third JR Record shows that all Sundays (1.1) will have release decisions at 8:00 am, 10:00 am, 12:00 noon, 2:00 pm and 4:00 pm. The fourth JR Record shows that on Mondays (2.2), Reservoir 10 will compute releases for all time periods.

G.4 System Power Records

G.4.1 SM Record - System Energy Requirements: Monthly (optional)

These optional records specify the monthly system energy requirements. If used, two SM Records are required. System power analysis may not balance reservoirs adequately where channel routing is used.

System power reservoirs (P2.3=1) within an HEC-5 model can be composed of 3 types of projects. Type 1 is a reservoir with energy drawdown storage located at the headwater of a tributary such that there are no reservoirs above that location. Type 2 is a run-of-river power project which has “no power drawdown storage” and is located downstream of a Type 1 reservoir. Type 3 is a power reservoir “with power drawdown storage” that is located downstream of a Type 1 reservoir. No reservoirs with energy drawdown storage can be incorporated in the HEC-5 power system (P2.3=1) unless they are either Type 1 or Type 3, meaning that they are either at the headwater of a tributary or are downstream of another system power project with drawdown storage. If a system power reservoir with drawdown storage exists which is not a headwater reservoir and does not have a system energy drawdown reservoir above it, but does have a non-system power reservoir above it, then a dummy system power reservoir must be added at the headwaters of the tributary with a 1 or 2 kW plant and no storage.

Field	Variable	Value	Description
1-12	PRWS[1]	+,0	Monthly system energy requirements in 1000 kWh. Specify monthly values in successive order, one value per field. Beginning with the system energy requirement for January (J1.2=1) in the first field.
13	FACT	+,0	If the 13th value (2nd SM Record, 3rd field) is a positive number, the initial 12 values are multiplied by this value (a convenient means of inputting the system requirements in terms of monthly plant factors).

[1] If PC and PF (or SC and SF) Records are used to describe power rule curve, these values are ratios which are multiplied times the plant factors on the PF (or SF) Records.

G.4.2 SD Record - System Energy Requirements: Daily (optional)

This optional record specifies ratios of the weekly system energy requirements for each day of the week (seven values required). The program computes the weekly requirements based on the monthly energy requirement (SM Records). If SH Record is used, the SD Record is required.

Field	Variable	Value	Description
1-7	PWRSD	+	Daily ratios of system energy requirements. Sum of the seven values must equal 1.0. The first value is for Sunday.
8-10			Not used.

G.4.3 SH Record - System Energy Requirements: Multi-hourly (optional)

This optional record specifies ratios of the daily system energy requirements for each time interval IPER (see BF.7) within a day.

Field	Variable	Value	Description
1	N	2-24	Number of ratios to be read starting in Field 2. Minimum number of values = 24/IPER, (e.g., for a six-hour simulation interval, at least four values would be required). The number of ratios used must agree with the PH Record for each reservoir project.[1]
2+	PWRSH	+	Ratios of the daily system energy requirements for each time interval (BF.7) within the day. First value represents the period starting at midnight. Sum of the values must equal 1.0.

[1] Any number of ratios from 1 to 24 can be used in conjunction with any multi-hourly time interval. If, for example, 24 ratios are read on the SH Record and a 4-hour simulation interval (BF.7) is selected, the program will automatically sum up the proper number of ratios in a 4-hour period. If the converse situation exists, where the SH Record is describing the energy requirements in intervals larger than the selected simulation interval, the program assumes the energy requirement is evenly distributed and calculates the proper ratios for the smaller simulation intervals.

G.4.4 SC Record - System Power Rule Curve: Ratios of Storage Capacity (optional)

This record is used in conjunction with the SF Record to define a rule curve for determining the monthly system energy requirements (in a similar manner to the PC Record for at-site energy).

When the SC Record is used, the SM Records are read as usual, but they represent monthly adjustment ratios of the plant factors on the SF Records. The PC and PF Records for at-site requirements would be normally omitted to allow maximum flexibility, but they can be used if desired. This method is an alternative method to firm system energy operation.

Field	Variable	Value	Description
1	NSC	2-9	Number of ratios on SC and SF Records required to define the system energy production rule curve.
2-10	PWRSC	0,+	Ratios of power storage occupied. NSC values, starting with smallest value. The ratios represent the sum of the occupied energy storages for all power system reservoirs divided by the sum of the energy storages available for all power system reservoirs.

G.4.5 SF Record - System Power Rule Curve: Plant Factors (optional)

This record, which must be used if a SC Record is present, is used in conjunction with the SC Record to define the rule curve for determining the system energy requirement based on the amount of power storage (storage between top of conservation pool and buffer level) occupied in the reservoir system.

Field	Variable	Value	Description
1	NSC	2-9	Number of ratios on SC and SF Records required to define the system energy production rule curve.
2-10	PWRSF	0,+	Plant factors (expressed in terms of decimal fractions) corresponding to SC Record values. NSC values must be supplied.

G.5 Trace Records

G.5.1 TC Record - Trace Record - Control Point Selection

The TC, TP and TS Records are normally used only by HEC personnel or by those users who can read FORTRAN and who desire to make program improvements or error corrections; up to 5 sets of TC, TP, and TS Records can be used. If more than 1 set is used, all 3 records must be used for each set. Multiple sets are used so that for a given time period (or periods), trace output for locations and/or subroutines can be different than other time periods in order to reduce the trace output volume.

All control points will be traced if this record is omitted and a TP Record is used. If both TC and TP Records are omitted, trace will not be printed for any time period or control point.

Field	Variable	Value	Description
1	NTRAMX	1-9	Number of location values on TC Record.
2-10	MXTRA(I)	+	Identification numbers of selected control points to be traced for periods and level of trace shown on TP Records (TP.10). The trace consists of additional output for major program loops and variables and are identified by subroutine and program statement numbers in the left hand margin. To read the trace, a listing of the program source code is required, as well as a knowledge of FORTRAN.

G.5.2 TP Record - Trace Record - Time Periods and Trace Level Selection (optional)

The trace level (TRACE, TP.10) is assumed = 15 if this record is omitted.

Field	Variable	Value	Description
1	NTRACE	1-8	Number of time period values on TP Record.
2		0	If NTRACE=1, a general trace before and after operation by period will be generated, but no trace will be generated from system operation.
2-9	ITRAP(I)	+	Selected time period numbers for trace. To trace period 10 of flood 2, as defined by BF-EJ Records, use 10.02. These values can exceed the dimension limit KPER. (Use 11.02 to trace period 1 of second automatic flood).
10	TRACE	0	Trace level is assumed = 15 if TC or TP Record is used.
		1[1]	Very small volume of trace showing how reservoir releases were determined.
		11	Trace of release computation.
		15	Comprehensive trace.
		17	Same as 15 except additional trace for diversions and routing coefficients.
		20	Comprehensive trace including Modified Puls trace.
		32	Trace of subroutine PRHEAD in post-operation (if 83 specified on TS Records).
		20+	NLEVTR (for System Power Routine) TP.10=20+ Reservoir level to be traced (i.e. TP.10 = 35 (20+15) will trace reservoir levels 14 and 15).

Example of System Power Allocation trace for Periods 35 - 37

```
TP     3     35     36     37     ...1
TS    95
```

[1] For system power, trace level 1 will give the system power allocation (for time periods specified). In addition, a TS Record requesting trace from subroutine SPREL (95) should also be used for allocation summaries for time periods being traced. Thus QA Records may be used to reduce unacceptable differences between system power energy required and generated where system power is controlling (CASE=.12).

G.5.3 TS Record - Trace Record - Subroutine Selection (optional)

If TS Record is omitted, all subroutines (1-194) that are used, are traced if trace level (TP.10) is high enough. If TS Record is used, subroutines will be traced if a positive (or zero) code number calls that subroutine. Subroutines that should be omitted from the trace are noted by a negative code. Subroutines which are to be traced can be defined using a combination of positive and negative codes on the TS Record.

Field	Variable	Value	Description
1-10	TRASUB (l)	+	Code describing subroutine(s) to be traced.
		-	Code describing subroutine(s) which should not be traced.

Examples

TS	0	-150.1	All subroutines will be traced except 150-157 (see following table).
TS	2	-50.1	All operations subroutines except 50-56 will be traced.
TS	117	112	Only subroutines 117 and 112 will be traced.

Codes for selecting HEC-5 subroutines using the TS Record:

HEC-5 General Subroutines

Code	Subroutine Name
0	All HEC-5A program subroutines (4,6-194)[1]
1	All PRE-operation subroutines (4, 6-35)[1]
2	All OPERATION subroutines (40-127)[1]
3	All POST-operation subroutines (150-194)[1]
4	HEC-5A subroutine/DSSNOB
5	All HEC-5B program subroutines

[1] Code to call or delete a **group** of subroutines.

HEC-5 Pre-Operation Subroutines

Code	Subroutine Name
5.1	**Routines 6-9[1]**
6	PRERD/TS Record
7	JOBRD
8	INCRD (no trace available)
9	DIMLIM
10.1	**Routines 10-33[1]**
10	IN
11	INITLZ
12	RDLBLS (no trace available)
13	RDMODL
14	RDJCDS
15	RDVJCD
16	PRRDSM
17	RDRES
18	PRRDCD
19	RDCP/RELCHG
21	RDROUT
22	RDDAMG
23	BASIN
24	RDBFSS/RELCHG
25	RDTSD
26	CRIPER
27	CRPDEQ
28	WRITQM
29	RDTSD8/RELDEC
31	INTAB/MAPGEN/MAPLIN/RESOPR
32	INTRES
33	INTDIV
34	(not presently used)
35	TSDCOD/LEVRES

HEC-5 Post-Operation Subroutines

Code	Subroutine Name
150.1	**Routines 150-157[1]**
150	OUTPUT/SUMMRY/USER5A/RRPERR
151	CASUSR
152	LEVL
153	CKMINQ
154	CKFLOD
155	CKRES/RELCHG
156	OUTIME
157	MOVARR
160.1	**Routines 160-161[1]**
160	OUTARR
161	PRPRNT
170.1	**Routines 170-174[1]**
170	OUTPER
171	OUTCP
172	OUTPOW
173	OUTDIV
174	OUTRES
180.1	**Routines 180-194[1]**
180	OPT
181	OPTAER
182	OPTERR
183	OPTDRA
184	OPEST3
185	OPPRNT
186	OPASMP
187	OPBNDY
188	OPESTM
189	OPMONV
191	OPDATE
192	OP1MOR
193	OPTP38
194	OPTWR

HEC-5 Utility Routines[2]

Code	Subroutine Name
198	CDATE (needs trace LEVEL = 20)
199	EVAP

[1] Code to call or delete a **group** of subroutines.

[2] No printout unless code appears on TS record.

HEC-5 Operation Subroutines

Code	Subroutine Name
40.1	**Routines 40-49[1]**
40	HMAIN/LEVRES/QMXPUL/TSCARD
41	RTCOEF
42	COMCOF (needs trace level=17)[2]
43	SUBCOF (needs trace level=17)[2]
44	MONPER
45	CHACAP/RELCHG
46	GUIDCV[2]
47	CONQAF
48	RLINT (needs trace level=17 or 18)[2]
49	FLOW
50.1	**Routines 50-56[1]**
50	LOCALQ
51	LOCINC
52	SCALE
53	PROF (no trace)
54	LOCCUM
55	OPTPRE
56	ADDLEV
60.1	**Routines 60-61[1]**
60	ROUT[2]
6l	MUSKRT (trace levels=15,20,25)
70.1	**Routines 70-75[1]**
70	DIVCOR[2]
71	DIVFRM
72	DIVRES
73	DVPUMP
74	DVRSMX
75	DVROUT
80.1	**Routines 80-82[1]**
80	POWER[2]
81	PRREL
82	PREREQ
83	PRHEAD[2, 3]

Code	Subroutine Name
90.1	**Routines 90-97[1]**
90	SYSPOW
91	SPQLEV
92	SPEQMN
93	SPADPT
94	SPFIXT
95	SPREL
96	SPCHCK/SYPRUL
97	PRELEV
98	SYPRUL
100.1	**Routines 100-105[1]**
100	MAINCP/QMXPUL
101	INFLOW
102	VCHCAP/RELCHG
103	BPCTFC
104	REQLEV
105	QTYTAB
110.1	**Routines 110-119[1]**
110	RELMX/DIVADJ/QA4250
111	QMINFC
112	RESROT
113	TANREL/TRELCN
114	PRESNO
115	QTABLV
116	SPACE1/DIVADJ
117	RESREL
118	FUTLEV/LEVRES
119	TQPREP
120.1	**Routines 120-127[1]**
120	FILL
121	TRACIP (no trace)
122	RELQMX
123	QSPACE
124	SCHEDP
125	FILSPA
126	SPATRY
127	MINREL

[1] Code to call or delete a **group** of subroutines.

[2] Subroutine is shown in only one group, but is actually called by other subroutines as well.

[3] No printout is available from subroutine PRHEAD unless code 83 appears on TS Record and time period on TP Record. For trace during post-operation also specify trace level TP.10=32.

G.6 Records for All Reservoirs

Records **RL**, **RO**, **RS**, and **RQ** are **required for all reservoirs**. **Omit for non-reservoirs**. The most upstream control point on each tributary must be a reservoir. Records RL-DC are repeated in turn for each control point (reservoir or information point) in downstream order until all control points have been specified. No downstream locations may be specified until all locations which route to that location are specified. The maximum number of control points KMXCPT (reservoir and non-reservoir) as well as the maximum number of reservoirs KMXRES is shown at the beginning of each HEC-5 output. If a control point is not a reservoir, Records RL-RG and P1-PE are omitted, and only control point Records CP-DC are used. If a reservoir is not a power plant, omit Records P1-PE. All control points above each confluence must be specified before the confluence control point. Last control point cannot be a reservoir. If your system has tandem reservoirs, read the tandem locations in first. Control points with diversions from that location should appear before the return point (diversion to). Model should start with most upstream location of the most complex tributary (after tandem reservoirs).

G.6.1 RL Record - Reservoir Target Levels

Field	Variable	Value	Description
1	MM	+	Reservoir identification number. Must be an integer.
		-	A negative identification number is used to specify a "**flow-through**" reservoir. The specification of a flow-through reservoir permits the summation of cumulative local flows to be continued through this reservoir. This option may be useful when it is necessary to operate an upstream reservoir for water supply goal below a "run-of-river" project.
2	STOR1	+	Starting **storage** of reservoir MM in 1000 m^3 (acre-feet).
		-	Initial **elevation** of reservoir MM in meters (feet).
3-17	STORL(M,L)	+	Cumulative reservoir capacities for reservoir MM in 1000 m^3 or acre-feet for each of NUMLEV levels (J1.3) starting with reservoir storage allocation level 1. If NUMLEV (J1.3) exceeds 8, two RL Records per reservoir are required. Level LEVBUF(J1.6) is the top of buffer pool. Level LEVCON(J1.4) is the top of conservation pool. Level LEVTFC(J1.5) is the top of flood control pool. For routing intervals less than monthly (or less than the length of the season described on the optional CS Record), input capacities represent conditions for cumulative days specified on CS Record or at end of month (if no CS Record). Interpolations between monthly or seasonal storage are made for each time period.

G.6.2 Additional RL Records (optional)

Additional RL Records can be used when reservoir storage allocation levels change during the year. These records will be read after the first RL Record(s) (storage level data will be ignored on the first RL Record(s) if additional RL Records are used). NUMLEV(J1.3) groups (one or two records each) of additional RL Records will be read in increasing order of level.

Field	Variable	Value	Description
1	L	1-40	Reservoir level number.
2	MM	+	Reservoir identification number.
3	IRPT	0	Storage values will be read for all 12 months. Two RL Records are required for this level. The first monthly value must correspond to the variable ISTMO(J1.2) (usually January). Seasons for RL Records are monthly. CS Records are not used at this reservoir. For daily routings, the monthly storage values represent **beginning** of month values and interpolations are made for each day. For monthly routings the monthly storage values are assumed constant for the entire month and may therefore be thought of as **end** of month values.
		-1	Storage in Field 5 will be used for all seasons. Only one RL Record for this level is required.
		3-36	Number of storage values to be read for Level L. Corresponds to the seasons described by cumulative days (in the calendar year). Seasons are specified on CS Records. **Do not use 12 values since this is reserved for monthly.**
4	FACTR	0	All storage values are read in 1000 m^3 (acre-feet).
		+	Storage in Fields 5-10 will be multiplied by FACTR.
5-10	STORL(M,L,K)	+	Reservoir storage for each season for level L. The first six values of storage appear on the first record in Fields 5-10, the next six values (if used) must be in Fields 5-10 of the second and subsequent records (Fields 1-4 are omitted). More than 1000 m^3 (1 acre-foot) of flood control storage should be shown for the first season if downstream CUMULATIVE LOCAL FLOW should not include local flows above this reservoir. Interpolation between monthly or seasonal storages are made for each time period.

G.6.3 RO Record - Reservoir Operation Points (required for reservoirs)[1]

1. **RO** Records are used to assign a reservoir to specific downstream control points for flood control and/or water supply release decisions.

2. For **flood control operation**, reservoir releases **for a non-reservoir control point** are based on not exceeding the channel capacities (CP.2) at the **RO** specified locations with consideration for uncontrolled local flows, forecast ability (J2.1), contingency allowance (J2.2), and routing effects. To effectively operate for downstream flood control goals, reservoirs should have both flood storage (J1.5, RL) and operable gates. In general, reservoirs should not be assigned to operate for control points below downstream tandem reservoirs that have flood control storage.

3. For **water supply operation**, reservoir releases **for a non-reservoir control point** are based on providing flow augmenting releases to sustain flow goals (minimum desired CP.3 or minimum required CP.4) at the **RO** specified locations with consideration for diversions, return flows, uncontrolled local flows, and contingency allowance (J2.2). To effectively operate for downstream water supply flow goals, reservoirs should have conservation storage (J1.4, J1.6, RL) and sufficient discharge capability (**RS**/**RQ**). In general, reservoirs should not be assigned to operate for control points below downstream tandem reservoirs that have conservation storage. In the special instance of operating a water supply reservoir for a location downstream of a "run-of-river" reservoir, accuracy in meeting flow goals can be improved by designating the run-of-river reservoir as a "**flow-through**" reservoir (e.g. RL.1= -location **(negative)** number).

4. For **flood control** and **water supply operation** for a downstream **tandem reservoir**, releases are based on balancing reservoir levels in both reservoirs. Multiple reservoirs in tandem may be chained together into the system by assigning each reservoir to operate for the next downstream reservoir in the system. In the special case of operating a **peaking hydropower** (**PD**, **PH**) reservoir for a downstream tandem reservoir, releases to balance levels will be made during power operation periods.

Field	Variable	Value	Description
1	NSERV	+	Number of downstream locations this reservoir will operate to prevent flooding or to provide water supply. If this reservoir operates for flood control, this value should be equal to one or more. All downstream control points may be used.
2+	ISERV(M,K)	+	Control point numbers for which reservoir is operated. NSERV values in any order. If reservoir MM is specified to be operated for the next downstream reservoir, MM will operate to balance levels in both reservoirs. In general, MM should not operate for control points below the next downstream reservoir. If flood routing is used (see RT Record), then all gated upstream reservoirs with flood control storage **which are operated in parallel** must operate for all downstream locations which are subject to flooding.

[1] Downstream locations which are operated for by Reservoir MM, are operated for time periods IFIRST to LOOK. IFIRST is the first time period where the current release would have a one percent or more effect. LOOK is the last time period within the allowable forecast period (J2.1 or R2.5). Where IFIRST for downstream operating locations is greater than LOOK, IFIRST is set equal to LOOK. Thus, reservoir releases will be curtailed if a downstream operation point is flooding at the **maximum forecast** period (LOOK) even though the reservoir release may not reach the downstream location during the forecast period. The controlling location in the program output, under CASE, is for the most downstream location that is flooding.

G.6.4 RS Record - Reservoir Storage (required for reservoirs)

Field	Variable	Value	Description
1	NK	2-60	Number of values of STOR(M,K) on this record and QCAP(M,K) on RQ Record. (Must be at least 2.)
		-	Number (negative) of values of STOR (as described above) to indicate that the values of STOR(M,K) are in 1000's of units on input records and will be multiplied by 1000 by the program.
2+	STOR(M,K)	+	Storage in 1000 m^3 (acre-feet) for reservoir MM corresponding to RQ Record outlet capacities. NK values must be supplied. First or second storage value should be the inactive storage value, and two successive values should not be equal. If more than 9 values are given, start in first field of second RS Record with tenth storage value.

G.6.5 QQ Record - Multiple Reservoir Outlet Capacities (Optional)

Optional data for the specification of multiple reservoir outlet capacities (RQ Records). Backwater effects from a downstream reservoir or non-reservoir which limit reservoir releases may be specified with a QQ Record and up to 10 RQ sets of NK outlet capacities. The QQ Record specifies the downstream location from which backwater conditions limit releases, the number of RQ sets, and the initial elevation for the first period of a simulation.

Field	Variable	Value	Description
1	LOCQQ	+	Location number of downstream reservoir or non-reservoir location from which backwater effects limit reservoir releases.
2	NUNQQ	2-10	The number of sets of reservoir capacity (RQ Record sets which follow this QQ Record)
3	QQDSEL	+	The initial elevation at location LOCQQ for the first period of a simulation.

G.6.6 RQ Record - Reservoir Outlet Capacities (required for reservoirs)

Field	Variable	Value	Description
1	NK	+	Number of values of QCAP(M,K) on this record and STOR (M,K) on RS Record,
	or, for **multiple RQ Record sets** (preceded by an optional QQ Record):		
1	QQDSEL	+	Reference elevation corresponding to downstream location LOCQQ (QQ Record). To simulate the effects of backwater, the first field of the RQ Record specifies the downstream elevation associated with the outlet capacities on this RQ Record. The RQ data sets are input from lowest to highest downstream elevation. (Maximum of 10 sets)
2+	QCAP(M,K)	+	Total outlet capacity in m^3/s (ft^3/s) for reservoir MM corresponding to RS Record storages. NK values must be supplied.
		-1	Unlimited outlet capacity at STOR(M,K). This option sets the outflow equal to the inflow when reservoir storage reaches the value of STOR that corresponds to a negative QCAP. This option should be used for all dummy reservoirs. This option should not be used if a gate regulation curve (RG Record) is used for this location.

G.6.7 RA Record - Reservoir Areas (optional, but required for evaporation)

Reservoir areas are given as a function of reservoir storage as defined on the **RS** records.

Field	Variable	Value	Description
1	NK	+	Number of values of AREA(M,K) on this record and STOR(M,K) on RS Record.
2+	AREA(M,K)	+	Reservoir areas in 1000 m^2 (acres) for reservoir MM corresponding to RS Record storages. NK values must be supplied.

G.6.8 RE Record - Reservoir Elevations (optional, but required for hydropower)

Reservoir elevations are given as a function of reservoir storage as defined on the **RS** records.

Field	Variable	Value	Description
1	NK	+	Number of values of EL(M,K) on this record and STOR(M,K) on RS Record.
2+	EL(M,K)	+	Reservoir elevations in meters (feet) for reservoir MM corresponding to RS Record storages. NK values must be supplied.

G.6.9 RD Record - Reservoir Diversions or Minimum Releases (optional)

Field	Variable	Value	Description
1	DVEXC	0	All diversions are made based on reservoir storage (RS Record).
		-1	**Diversions** are equal to the excess flood waters above the top of conservation up to the outlet capacity of the diversion pipe (FDQ). The second value on this record must be greater than 0.0. Use DR.7 = -2 for this option. Can be used to simulate uncontrolled spillways.
		-10	When the gate regulation curve operation is used (RG Record) the induced surcharge envelope curve values (minimum reservoir releases during emergency conditions) can be shown on RD and RS Records, and maximum reservoir releases vs. reservoir storages on RQ and RS Records. For this option only, **do not use DR Records** since reservoir releases determined from this option will not appear as diversions. (Applies to rising limb of hydrograph only.)
2+	FDQ(M,K)	+	Diversion discharges from reservoir MM corresponding to values of STOR(M,K) on RS Record. If Field 1 is -1, Field 2 must be greater than zero (use .01 or greater). NK values (RS.1) must be supplied.

G.6.10 R$ Record - Reservoir Costs (optional)

Field	Variable	Value	Description
1	NK	+	Number of values of COEF on this record and storages, STOR (M,K), on the RS Record.
2+	COEF	+	Reservoir capital costs (present worth) corresponding to the storages on the RS Record. The storage at the top of flood control pool (RL Record storage corresponding to level LEVTFC from the Field 5 of the J1 Record) will be used as the reference level for storage to determine the cost of the project from the RS and R$ Records. Values should be in the same units as damages (i.e., $, $1,000, etc.).

G.6.11 R1 Record - Multiple Flood Data Starting Storage or Hydropower Capacities (optional)

Field	Variable	Value	Description
1	N	1	Starting storages for reservoir MM (see Record RL.1) for floods 2-9 (either BF through EJ Records or use of flood ratios on FC Record) will appear in Fields 2-9 of this record.
		2	Installed hydropower capacities (see Record P1.2) for reservoir MM for floods 2-9 (either BF through EJ Records or use of flood ratios on FC Record) will appear in Fields 2-9 of this record.
2+	TSTOR1(K)	+	Starting storage (if N = 1) or installed capacities (if N = 2) for flood 2, 3, 4, etc. (K = up to 9).

G.6.12 R2 Record - Additional Reservoir Data (optional)

Field	Variable	Value	Description
1	RTCHGR[1]	0	The rate of change on Field 3 of the J2 Record (or a default value of .04 per hour) will be used for this reservoir (RL.1).
		+	The allowable rate of change of **increasing** reservoir releases, during a one-hour time period, when the release from this reservoir **increases** from the previous period. If RTCHGR is **greater than two** (2), expressed as flow in m^3/s (ft^3/s) per hour. If RTCHGR is **less than two** (2), expressed as a ratio (per hour) to the channel capacity at this reservoir (CP.2 or CC Record) during a one hour time period.
2	RTCHGF[1]	0	The rate of change on Field 3 of the J2 Record (or a default value of .04 per hour) will be used for this reservoir (RL.1).
		+	The allowable rate of change of **decreasing** reservoir releases, during a one-hour time period, when the release from this reservoir **decreases** from the previous period. If RTCHGF is **greater than two** (2), expressed as flow in m^3/s (ft^3/s) per hour. If RTCHGF is **less than two** (2), expressed as a ratio (per hour) to the channel capacity at this reservoir (CP.2 or CC Record) during a one-hour time period.
3	EVRTO	0,+	If greater than zero, factor is multiplied times the evaporation rates on EV, J6, and R3 Records.
4	RELSTR	0	Program will determine reservoir release for the first time period.
		+	Reservoir release for the first time period will be RELSTR. program will determine releases for subsequent periods.

[1] Ignored for weekly or longer routing intervals.

Field	Variable	Value	Description
5	IFCST(M)	0	The foresight shown on J2.1 for inflows and local flows will be used for reservoir MM when short interval routings are made, i.e., when IPER (BF.7) is less than or equal to NOROUT (J3.7).
		+	IFCST(M) hours of foresight for inflows and local flows will be used for reservoir MM when IPER is less than or equal to NOROUT.
		-	If a negative number is entered, the number refers to a reservoir location which will be the basis for evaporation calculations at this reservoir. Computed evaporation at the specified reservoir will be distributed between both reservoirs, based on the ratio of storage in this reservoir to the storage in the specified reservoir.
6	HPOINF(M)	0	No hinged pool operation.
		+	Inflow magnitude (m^3/s or ft^3/s) above which the reservoir top of conservation storage will be reduced from RL data to HPOSTG(M). This hinged pool operation is sometimes used on navigation locks.
7	HPOSTG(M)	0	No hinged pool operation.
			Storage (1000 m^3 or acre-feet) at top of conservation pool when inflow is at or above HPOINF(M).
8	IOPMX(M)		Reserved for future use.
9	IPRIMX(M)		Reserved for future use.
10	ITAPER(M)[1]		Flood Control Drawdown Option for **Real-time Water Control Applications**:
		+	Number of **hours** (after forecast time) that the reservoir will "taper" its releases in order to complete its flood control drawdown.
		-1	HEC-5 will **calibrate** the flood control drawdown using the "slope" of the previous releases (prior to time of forecast).
		0	Taper logic **not used**. HEC-5 will evacuate flood storage as soon as possible (i.e., using downstream channel capacities as well as the reservoir rate-of-change and outlet capacity constraints).

[1] For Real-time Water Control Applications (typically using MODCON), the HEC-5 execution line includes Forecast Date and Time which are used in conjunction with ITAPER. An example HEC-5 execution line follows:
H5A I=BASIN.DAT O=BASIN.OUT DSS=BASIN.DSS RT=ON **FD=19FEB86 FT=1200**

G.6.13 R3 Record - Reservoir Evaporation (optional)

Optional data for varying the monthly net evaporation rates (net=evaporation-precipitation) for reservoir MM, instead of using the monthly basin evaporation on the J6 Records. Non-monthly evaporation rates must be read on EV Records. If used, two R3 Records are required.

Field	Variable	Value	Description
1-12	EVRATM(K,M)	+ or -	Monthly net evaporation rates in millimeters (inches) over the reservoir area for 12 monthly periods. The first month of the evaporation must correspond to ISTMO (J1.2), usually January.

G.6.14 RG Record - Gate Regulation Curve (optional)[1]

Field	Variable	Value	Description
1	ELTSUR(M)	+	Elevation in meters (feet) of top of induced surcharge (usually 1 to 5 feet above top of flood control pool). If this elevation does not exceed Field 2, the program will assume .1 meter (foot) higher than Field 2.
2	ELSURO(M)	+	Elevation in meters (feet) of bottom of induced surcharge (usually equal to top of flood control pool).
3	QSURO(M)	0,+	Discharge in m^3/s (ft^3/s) on induced surcharge envelope curve at elevation "ELSURO" (should be equal to channel capacity or less) used to develop default induced surcharge envelope curve when no RD Record.
4	TSCON(M)	+	Constant representing recession of hydrographs in **hours** (see EM 1110-2-3600).
5	SPWID(M)	+	Width in meters (feet) of spillway excluding piers (used in calculating approximate gate opening).
6	ELSPI(M)	+	Elevation in meters (feet) of spillway crest.
7	QMIN1(M)	0	One hundred percent of flood control storage will be used.
		+	Percent of flood control storage above which emergency transition releases will be made (HEC-5 output case = 23 or 21) if not using RD Record.
8	CQELSP(M)	0,+	Physical conduit discharge in m^3/s (ft^3/s) at spillway crest.

[1] A default induced surcharge envelope curve will be assumed if not given on RD Record (-10 for first field of RD Record).

When an RG Record is used, the RE Records are also required. The pre-release option (J2.5) if used, is not applied for any project that has an RG Record.

The RG Record should not be used for an uncontrolled spillway.

Field	Variable	Value	Description
9	ITYSP(M). TYOPFL(M)	X.Y	A "2-part" value where the "X-part" specifies the time interval to be used in Gate Regulation Curve calculations and the "Y-part" specifies the Recession Operation Code (.0 or .1). The "Y-part" indicates the type of operation to be followed when emergency releases have been made and the pool has fallen to the top of the flood pool.
			X-Part
		X=1	Gate regulation curve calculations will be based on the average inflow during the previous **one** hour.
		X=2	Gate regulation curve calculations will be based on the average inflow during the previous **two** hours.
		X=3	Gate regulation curve calculations will be based on the average inflow during the previous **three** hours.
			Y-Part
		Y=.0	Releases will be based on **average** of previous period's outflow and the current period's inflow (Case=0.22).
		Y=.1	Release will be based on **outflow=inflow** until normal flood control releases can be resumed (Case=0.23).
10	ELOPMN(M)	0	Emergency transition releases are made to the top of flood pool.
		+	Releases defined by this elevation and code Y (RG.9) will be made until normal "downstream based" flood control releases can be resumed. This elevation and code Y will determine releases when Gate Regulation Curve releases have been made and reservoir storage has fallen to or below the top of the flood pool.

G.7 Records for Hydropower Reservoirs

G.7.1 P1 Record - Hydropower Capacity, Efficiency, Overload (required for hydropower reservoirs)

This record specifies physical characteristics of a powerplant located at this reservoir. **Omit** records P1-PE if no powerplant exists; next record would be a CP Record for this reservoir without a powerplant.

Field	Variable	Value	Description
1	LOC	+	**Location** identification number (same as RL.1 and CP.1)
2	PWRMX[1]	+	Rated **capacity** in kilowatts (kW). Station service units are usually excluded. For optimizing **proposed** power projects (using J7 Record), use value of 1.0.
		-	**Pumping capacity** in kW (for pumped storage simulation, DR.7= -3).
3	OVLOD	+	**Overload ratio** for the power installation. Many older plants have been designed with 1.15, but many recent projects are designed for 1.0. If left blank, program assumes 1.0.
4	IPOW	0	Power peaking capability function will not be used. This means that the only limitation of power output will be the powerplant rated capacity.
		1	Peaking **capability** vs. reservoir **storage** relationship will be read on records **PP** and **PS** and used to calculate the turbine-generator capability as a function of reservoir storage. This option is used when head fluctuations are primarily dependent upon headwater fluctuations.
		2	Peaking **capability** vs. reservoir **release** relationship will be read on records **PP** and **PS** and used to calculate the turbine-generator capability as a function of reservoir release. This option is used when head fluctuations are primarily dependent upon changes in tailwater.
		3	Peaking **capability** vs. reservoir operating **head** will be read on records **PP** and **PS** and used to calculate the turbine-generator capability as a function of reservoir head. This option is more accurate than using IPOW=1.

[1] For optimizing **existing** power project (with J7 Record), enter the existing installed capacity (optimization will not optimize to value less than existing).

Field	Variable	Value	Description
5	TLWEL[1,2]	0	**Tailwater elevation** will be based on reservoir release relationship (**PQ** and **PT** Records) or elevation at downstream reservoir (**P1.6**).
		+	Tailwater elevation in meters (or feet). For hydroelectric projects providing "peaking" power, this should be a "block-loading" or average "on-line" tailwater elevation that would be expected normally during periods of power generation.
6	IDPR[2]	0	Indicates that there is no downstream reservoir whose elevation affects tailwater elevation at this powerplant.
		+	Location number of **downstream reservoir** (or control point if EL Records are used after BF Record) whose elevation affects **tailwater** elevation at this powerplant.
		-	Location number of reservoir whose elevation affects **headwater elevation** at this powerplant.
7	EFFCY	0	Standard ratio of .86 for generator-turbine efficiency is used.
		+	**Generator-turbine efficiency** expressed **as a ratio**.
		-1	**Generator-turbine efficiency** vs. **reservoir storage** relationship or vs. operating **head** is specified on **PE** Record. If the values on the PE Records are greater than 1.0 (an impossible efficiency), the integer portion of the value represents the head corresponding to the efficiency in the remainder of the value.
		-2	kW per m^3/s (ft^3/s) coefficient vs. reservoir storage relationship is specified on PE Record.
8	HLPO	+	Fixed **head loss** in meters (or feet).
9-10			Not used.

[2] Tailwater used by the program is the highest of the block-loading tailwater (P1.5), the tailwater based on downstream reservoir (P1.6 if used), and the tailwater rating curve (PQ and PT if used).

[3] If a J7 Record is used and this field is blank, a block-loading tailwater will be calculated using 100% of discharge required to produce installed capacity.

G.7.2 P2 Record - Hydropower Penstock Capacity, Leakage (optional)

Field	Variable	Value	Description
1	QLKG	0,+	**Leakage** through or under dam or powerhouse (or fish ladder or navigation lockage flows) in m^3/s (ft^3/s). Used to specify water which continuously passes the dam but cannot be used for power generation.
2	PENQ	0	Penstock discharge capacity will **not** be considered when making power releases.
		+	Maximum **penstock discharge capacity** for power releases. Program will convert the penstock capacity to an average discharge over the time interval based on the plant factor for that time period. The computed power release will be checked to ensure it does not exceed the penstock capacity.
3	MPSYS	0	This power plant is not a part of a power system but will be operated for at-site energy requirements.
		1	This **reservoir is part of a power system** and will be operated for the system (if there is power storage) while observing minimum requirements for at-site energy as expressed on PR Records. Run-of-river project whose output should be included as part of the system must use a 1 for power system 1. (Only referenced if SM Record is used.)
4	PFMAX	0	No system power is used or PFMAX is assumed to be equal to OVLOD (P1.3).
		+	**Maximum plant factor** for power generation from this project to contribute to meeting **system power load**. Must be equal to or less than OVLOD (P1.3). Generation rates greater than indicated by PFMAX will be permitted when excess water is available, but only the portion of generation up to PFMAX is considered to be usable in meeting the system load.
5-10			Not used.

G.7.3 PC Record - Hydropower Rule Curve (optional)

This record is used in conjunction with the PF (and optionally with the PB Record) to define a rule curve for determining energy production. The energy schedule is based solely on the amount of power storage, expressed in terms of the **percent of power storage** available (from top of conservation pool to top of buffer pool). This method is an alternative method to firm energy operation (see PR Record footnote).

Field	Variable	Value	Description
1	NPC	2-9	Number of ratios required to define the energy production rule curve.
2-10	RSPF	0,+	Ratio of conservation storage which may exceed 1.0. NPC values must be supplied starting with smallest value.

G.7.4 PF Record - Hydropower Rule Curve (optional)

This record, which must be used if the PC Record is present, is used in conjunction with the PC Record to define a rule curve for determining energy production and defines the amount of energy to generate (expressed as a plant factor) based on the amount of **power storage** in the reservoir (PC Record).

Field	Variable	Value	Description
1	NPC	0	All plant factors will be assumed to be 1.0.
		2-9	Number of plant factors required to define the energy production rule curve. (Must be equal to NPC (PC.1).)
2-10	RSPG[1]	0,+	Plant factors (expressed in terms of decimal fractions) corresponding to PC Record values. The plant factor for "0%" power storage will be applied below the top of buffer pool if a power drawdown priority (J2.4=2) is specified.

[1] These ratios are multiplied by the ratios shown on the PR, PD and PH Records.

G.7.5 PB Record - Hydropower Benefit Rate (mills/kWh) vs. Plant Factor (optional)

This record can be used in conjunction with the PC/PF Records to define the value of energy generated as a function of the project plant factor.

Field	Variable	Value	Description
1	NPC	0	Hydropower Benefit rate assumed to be zero.
		2-9	Number of values required to define the benefit relationship (must be equal to NPC (PC.1)).
2-10	RSMS	0,+	Energy benefit values (expressed in terms of mills/kWh) corresponding to PF Records.

G.7.6 PR Record - Hydropower Energy Requirements - Monthly (required for hydropower reservoirs)

This record specifies the monthly at-site requirements (1000 kWh or plant factors) for this project. Two records are required.

Field	Variable	Value	Description
1-12	POWRM	+	Monthly at-site **energy requirement** in 1000 kWh. Specify 12 values in successive order, one value per field beginning with January (J1.2=1)
		"or"	
		+	If **PC**, **PF** and **PB** Records are used, these monthly values (PR Records) are simply adjustment ratios of the plant factors (PF Records) and not firm energy requirements.
		-	At-site energy requirement as **plant factor** ratio times -1.0. Specify 12 monthly **negative** values starting with January (J1.2=1).
13	COEF	0	Factor of 1.0 is multiplied times all POWRM values.
		+	Factor COEF is multiplied times all POWRM values.
14	PRCRAT	0	Power guide curve factor not used.
		+	Power guide curve factor. When project for previous time period is above the top of buffer pool or LEVPRC (J1.9), the at-site energy requirements (from PC vs. PF Record or just PR Record data) will be multiplied by PRCRAT. When below this pool, a factor of 1.0 will be used.

G.7.7 PD Record - Hydropower Energy Requirements - Daily (optional)

This optional record specifies **peaking power** generation requirements for daily and hourly simulations. When the PD Record is used in conjunction with PR Records (only), the PD values are **percent** multipliers (e.g. PD 0, .2, .2, .2, .2, .2, 0) which distribute the monthly **energy requirement** over the days of a week. When the PD Record is used in conjunction with PC, PF, and PR Records, the PD values are **ratio** multipliers (e.g. PD 0, 1, 1, 1.5, 2, 1, 0) of PF plant factors.

Zero values indicate days during which power generation is not required. In the instance of a peaking power reservoir which also operates for a **downstream tandem reservoir**, tandem releases (case .05) will not be made during a day with a zero PD value. If it is necessary to make a tandem release in this instance, during a non-power day, a small value (say .0001) should be specified in place of a zero value.

Field	Variable	Value	Description
1-7	POWRD	0,+	Daily/weekly ratios (less than 1.0) of at-site energy requirements. Sum of the seven values must equal 1.0. The first value is for Sunday.
		"or"	
		0,+	If PC, PF and PB Records are used for this reservoir, these daily values are used as ratios to adjust PF plant factors. To turn off power requirements for a particular day, enter a zero.

G.7.8 PH Record - Hydropower Energy Requirements - Multi-hourly (optional)

This optional record specifies ratios of the daily energy requirements for each time interval (IPER, BF.7) within a day.

Field	Variable	Value	Description
1	N[1]	2-24	Number of ratios to be read starting in Field 2 for all power plants. The number of values must be greater than or equal to 24/IPER, e.g., for a 6-hour simulation interval, four or more values would be required. If 24 hourly values are given and the simulation interval is 6 hours, ratios will be summed as appropriate.
2+	POWRH[2]	0,+	Ratios (less than 1.0) of the daily energy requirements for each time period within the day. First value represents the period starting at midnight. Sum of the values must equal 1.0.
		"or"	
		0,+	If PC, PF and PB Records are used for this reservoir, these hourly values are used as ratios to adjust PF plant factors. To turn off power requirements for a particular hourly period, enter a zero.

[1] All power reservoirs must use the same number of values.

[2] Flexibility in pumping (or generating) additional hours on certain days of the week can be obtained by using digits to the left of the decimal point to indicate applicable days. For example, if the fifth hourly value on the PH Record is 17.10, then pumping (or generation) would occur from 4-5 a.m. on Sunday (Day 1) and Saturday (Day 7), with no pumping or generation from 4-5 a.m. on the other 5 days. In this case, the sum of the ratios can exceed 1.0. A zero to the left of the decimal implies every day of the week.

G.7.9 PQ Record - Hydropower Releases (optional)[1]

Field	Variable	Value	Description
1-10	QT	+	Reservoir **outflow** in m^3/s (ft^3/s). Begin with lowest value in Field 1 and specify values in increasing order. Values should cover the range of discharges expected. Program uses linear interpolation between points, so values should be selected so that linear interpolation is reasonably accurate. If less than 10 values are needed, the unneeded fields should be left blank. Used with PT Record to specify tailwater rating curve and optionally with the PL Record to specify hydraulic losses.

G.7.10 PT Record - Hydropower Tailwater (optional)

The number of values on this record must be the same as the number of values on the **PQ** Record.

Field	Variable	Value	Description
1-10	TL[2]	+	Tailwater **elevation** in meters (or feet) corresponding to reservoir outflow in same fields on the PQ Record.

G.7.11 PL Record - Hydropower Losses (optional)

The number of values on this record must be the same as the number of values on the **PQ** Record.

Field	Variable	Value	Description
1-10	HL[2]	+	Hydraulic **losses** in meters (or feet) corresponding to power release outflow in same fields on the PQ Record.

[1] PQ and PT Records are used to specify the tailwater-discharge relationship at this powerplant instead of using TLWEL (P1.5). A maximum of ten values can be used to define the relationship.

[2] Normally, this curve is used with **average** reservoir releases to obtain an average tailwater (and or hydraulic losses) for run-of-river projects or to obtain a tailwater (and hydraulic losses) for storage projects where flood control releases cause higher than normal tailwater. When a J7 Record is used to maximize the firm energy for a proposed powerplant (P1.2, LE.1), the tailwater is based on the discharge required to produce 100% of the installed capacity (discharge used for tailwater=average discharge/plant factor).

G.7.12 PP Record - Hydropower Peaking Capability (optional)[1]

Field	Variable	Value	Description
1-10	PKPWR	+	Maximum **peaking capability** in kW. The capability must correspond to the specified values on the PS Record. Program uses linear interpolation in this table; values should be selected so that linear interpolation is reasonably accurate.

G.7.13 PS Record - Hydropower Storages (or Releases, or Head) (optional)

The data on this record can be either reservoir storages, reservoir releases, or reservoir operating heads. Reservoir storages are specified if IPOW (P1.4) is 1; reservoir releases are specified if IPOW is 2; and operating heads are specified if IPOW is 3. The number of values on this record must be the same as the number on the PP Record. The largest value should be larger than the highest storage, release, or head anticipated. The smallest value should be smaller than the lowest storage, release, or head anticipated.

Field	Variable	Value	Description
1-10	CQOEL	+	Reservoir **storage** in 1000 m^3 (acre-feet) if IPOW (P1.4) is 1; reservoir **release** in m^3/s (ft^3/s) if IPOW is 2; or **head** in meters (feet) if IPOW is 3. Begin with smallest value in the first field and specify values in increasing order. Values must correspond to peaking capabilities on the PP Record.

[1] PP and PS Records define the relationship between peaking capability and either reservoir storage, reservoir outflow, or power head. P1 Record, Field 4 must be equal to 1, 2, or 3 to determine type of data being read. A maximum of 10 values can be used to define the relationship.

G.7.14 PE Record - Hydropower Efficiencies vs. Storage (optional)

This record is used to specify the relationship between reservoir storage (**RS** Record) and either plant efficiency ratio or kW per m^3/s (ft^3/s) coefficient, rather than using a fixed efficiency of EFFCY (P1.7). Additionally, this record is used to specify efficiency as a function of operating head. If EFFCY (P1.7) is specified as -1, plant efficiency ratios are specified on this record. If EFFCY is specified as -2, kW per m^3/s (ft^3/s) coefficients are specified. The number of values on this record must be the same as the number of storage values on the **RS** Record(s). Note however, that the first storage on the **RS** Record appears in Field 2 while the corresponding (first) efficiency on the **PE** Record is in Field 1. Thus corresponding values are offset one field.

Field	Variable	Value	Description
1-10	EFCY	+X.Y	Plant efficiency ratio equal to X (Y is ignored) if EFFCY (P1.7) is -1; or, kW per m^3/s (ft^3/s) coefficient, if EFFCY is -2. Values must correspond to storage values given on the RS Records. If EFFCY (P1.7) is -1 and EFCY value is greater than 1.0 (an impossible efficiency), the value to the left of the decimal point (X) represents the head (in meters or feet) corresponding to the efficiency to the right of the decimal point (Y).

G.8 Control Point Records for Operational and Hydrologic Data

Records **CP**, **ID**, and **RT** are **required** for all control points including reservoirs.

G.8.1 CP Record - Control Point Operational Data (required)

Field	Variable	Value	Description
1	MM	+	Location identification (integer) number. Must be equal to MM on the RL Record (RL.1) if this control point is a reservoir.
2	QMX(M)	+	Maximum flow (non-damaging channel capacity) in m^3/s (ft^3/s) at control point MM. Must be greater than 1.0.
		-	Stage, in meters (feet), for location MM at which upstream reservoirs operating for location MM will make minimum releases. Stage hydrographs for location MM may be read on EL Records with other time series data such as inflows (IN Records).
3	QMIND(M)	0	Minimum flow, if any, is specified on QM or MR Records.
		+	Constant minimum **desired** flow at control point MM for all periods. Minimum desired flows will be met as long as upstream reservoirs are above Buffer level LEVBUF (J1.6).
4	QMINR(M)	+	Constant minimum **required** flow at control point MM for all periods. The target flows will be reduced from the desired flows to the required flows when upstream reservoirs are below Buffer level LEVBUF(J1.6) and are above Level 1.
		-	Minimum required flow will be set equal to the minimum desired flow(s) (either from CP.3 or QM or MR Records) and therefore can vary from month to month or period to period. The value of QMIND (CP.3) will be ignored if QM or MR Records are used. A dummy control point is required if it is necessary to specify time varying desired **and** required flows at the same location.
5	QMDRAT	0	Ratio of 1.0 will be used.
		+	Ratio which is multiplied times minimum desired flow(s) (CP.3, QM, or MR Records).
6	CFLD(M)	0	Factor CFLOD(J2.2) will be used for contingency factor.
		+	Contingency factor (equal to one or more) for forecasting cumulative local flows at control point MM.

Field	Variable	Value	Description
7	LEVCPT	0	Cutoff level will be same for all locations (based on buffer level or level 1 (see IPRIO, J2.4)).
		+	Level number below which all conservation demands (minimum flows, diversions, power requirements) for this control point will be ignored by reservoir(s) serving this location.
8	CCRTR(M)[1]	0	An unlimited increase in channel capacity can be made when using CG Record criteria.
		+	Allowable **increase** in channel capacity from the previous period (if CG Record is used) in m^3/s (ft^3/s).
9	CCRTF(M)[1]	0	An unlimited decrease in channel capacity can be made when using CG Record criteria.
		+	Allowable **decrease** in channel capacity from the previous period (if CG Record is used) in m^3/s (ft^3/s).
10			Not Used

[1] If values are less than or equal to 2, they represent ratios of channel capacity.

G.8.2 ID Record - Identification Record for Control Point (required)

Field	Variable	Value	Description
1-4	CPT(M)	any	Title (alphanumeric) of control point in columns 3-32. Columns 3-11 will be printed in J8/JZ summary output.
5-10			Not used.

NOTE: When using **HEC-DSS** (JZ, ZW, ZR Records), the following will apply (see G.11):

1-2	NAMCPO	any	The control point name which is the B part of the pathname to be used with the **ZW** Record to identify any **output data which may be stored** to HEC-DSS.
3-4	NAMCPI	"blank"	If this field is blank, the output name for HEC-DSS (NAMCPO) will be used for the input name (NAMCPI).
		any	The control point name used with the **ZR** Record to identify the **input data which will be read** from HEC-DSS.
5-10			Not used.

G.8.3 C1 Record - Additional Control Point Data (optional)

Field	Variable	Value	Description
1	LQCP(M)	0	Flows for location MM are read from IN Records.
		+	IN Records do not have to be read for control point MM; instead, flows for MM can be based on values on IN Records for the same or another control point LQCP(M) in the system. Flows for MM are equal to factor RTLQ(M) multiplied times the flows on the IN Records for location LQCP(M) and lagged by QLAG(M).
2	RTLQ(M)	0	Flows will be based on factor of 1.0 times flow for location LQCP(M).
		+	Ratio which is multiplied by flows at LQCP(M) to obtain flows at location MM.
3	QLAG(M)	0	No lag.
		+ or -	Number of periods local flows are to be lagged forward (+) or backward (-) in time, expressed in IPER (BF.7) units.
4	IPLOT		This option is no longer used since the DSPLAY program plots hydrographs of data stored in HEC-DSS.
5-10			Not Used.

G.8.4 C2 Record - Additional Control Point Data (optional)

Field	Variable	Value	Description
1	CRFAC	0	Capital recovery factor from J4.4 will be used for this control point.
		+	Capital recovery factor for this control point or reservoir to convert present worth cost (R$ or C$ Records) to an annual figure.
2	OMPER	0	No operation and maintenance costs.
		+	Percentage of capital cost, that will be required for annual operation, maintenance and replacement of the facilities (reservoir or local protection works).
3-10			Not used.

G.8.5 RT Record - Routing Record (required)

Field	Variable	Value	Description
1	RTFR(M)	+	Control point number of upstream end of routing reach. Equal to MM on the CP Record (CP.1).
2	RTTO(M)	+	Control point number of downstream end of routing reach. Equal to MM of the CP Record for the next downstream control point. May be left blank for last control point in system (last point must be a non-reservoir).
3	RTMD(M)	0	No routing. Fields 4 and 5 ignored.
		+X.Y	Number of subreaches (X), maximum of 12, (to the left of decimal) and codes (Y) for method of routing (to the right of the decimal).
			Code
			Y = 1 for Straddle-Stagger and Tatum,
			Y = 2 for Muskingum,
			Y = 3 for Modified Puls,
			Y = 4 for Working R&D,
			Y = 5 for Modified Puls as a function of inflow,
			Y = 6 for SSARR Time of Storage,
			Y = 9 for given Routing Coefficients values
			A 3.2 indicates three subreaches will be used in the Muskingum method. **NOTE:** Methods 3, 4 and 5 require QS and SQ Records. The QS and SQ Records are required for Method 6 if Fields 4 and 5 are 0. Method 9 requires CR Records.
4	X[1]		Routing coefficient "X" for each subreach of the reach. The value depends on the routing method used, as follows:
		+	**Method 1**, enter the number of ordinates for **straddle-stagger** (such as 3.1 for 3/1 straddle-stagger). For routing by the **Tatum** (successive average-lag) **method**, enter a 2.1 and make the “X part” of RTMD (Field 3) equal to the integer value of 2K/IPER+1 (where K is the travel time in hours and IPER is the simulation time interval (BF.7)).
		0	**Method 2** and **Method 4,** enter the **Muskingum** X coefficient between 0 and .5. Zero value gives a maximum attenuation and a .5 value gives none (direct translation of hydrograph).

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[1] Do not use routing criteria that specifies that outflows are a function of future period inflows (e.g., Straddle-Stagger of 3/0). The 3/0 Straddle-Stagger would have outflow for the present period equal to 1/3 the inflow for the previous, present, and future periods.

Field	Variable	Value	Description
		0,+	**Method 6**, zero value indicates Time of Storage (T_s) will be defined in table form on QS and SQ Records. Non-zero value defines variable **n**; the exponent of Q in the equation T_s=KTS/Q**n**.
		0	**Method 3, Method 5** and **Method 9**, enter zero (0).
5	K		Routing coefficient K value depends on the routing method used, as follows:
		0	**Method 1, 3, 4 ,5 or 9**, enter zero (0).
		+	**Method 2**, travel time (K) in **hours** for Muskingum **subreach**. Total travel time will be the product of number of subreaches and value of K. To avoid negative coefficients, value of K should approximately equal the computational time interval (IPER, BF.7). Value of K must be greater than IPER/[2*(1-X)] and less than IPER/2X (where X is the Muskingum X coefficient (RT.4)).
		0,+	**Method 6**, zero value indicates T_s will be defined in table form on QS and SQ Records. A positive value defines variable **KTS** in the routing equation T_s = **KTS**/Qn.
6	LAG	0	No lag in addition to routing.
		+	In addition to routing specified by Methods 1-5, lag outflow by the number of periods shown in this field.
7	RTPER(M,I)	0	First RT Record criteria for this control point (MM) will be used whenever flood routing is done.
		+	Time interval applicable to this RT Record. A second RT Record can be used to describe a second set of RT data (second RT Record is limited to linear routing method; i.e., Modified Puls and R&D are not allowed). The second RT Record criteria will be used only if IPER (BF.7) is equal to RTPER; otherwise the first RT Record criteria will be used.
8	RTMNAT(M)	0	The routing criteria specified on this record will be used for all flow types (natural, regulated, etc.).
		1	The routing criteria specified on this record will be used **only** for **natural flow** calculations. No routing will be performed for other types of flows. This option allows the inflows specified at headwaters of a reservoir (specified as a dummy reservoir) to be routed through the reach, which is now occupied by water in the reservoir.
9-10			Not used.

G.8.6 CR Record - Routing Coefficients (optional)

Field	Variable	Value	Description
1	NUMCOF(M)	+	Number of routing coefficients on this record(s). Maximum number of values = 11.
2+	TRTCOF (M,K)	+	Routing **coefficients** to be used in this reach for routing **Method 9** (see RT.3). Sum of coefficients must equal 1.0.

G.8.7 WR Record - Water Rights Diversion Data

Optional record to specify water rights limits for diversion options. Data includes priority date, start and end dates (Julian days) and water-right volume in acre-feet. Input WR Record directly prior to the DR Record.

Field	Variable	Value	Description
1	IDPRIO	+	Date of water right (for use in determining relative priority among water right divertors). Format of date entry is similar to BF Record FLDAT (2 digits each for year, month and day), for example: a water right approved on 10 June 1937 is entered as 370610.
2	IDSTART	1-364	Starting date for diversion (in Julian days). As an example, a diversion for irrigation which begins on April 15th, would be entered as 105.
3	IDEND	2-365	Ending date for diversion (in Julian days).
4	WRVOL	+	Water right volume in acre-feet.

G.8.8 DR Record - Diversion Data for Control Point (optional)

For diversion requirements to be satisfied by upstream reservoirs, RO Records must specify that one or more reservoirs will operate for the diversion location. The maximum number of diversions is displayed in the program "banner" (see output file just prior to the data file listing).

Field	Variable	Value	Description
1	DRTFR(NDIV)	+	Control point identification number (same as MM on CP Record) where diversion is **made "from"**.
2	DRTTO(NDIV)	0,+	Control point number where diversion **returns "to"** system. Diversion flows will be routed from MM to DRTTO(NDIV). Can be zero if there is no return flow.
3	DRTMD(NDIV)	+	Routing method for diversion. (See RTMD of RT Record, Field 3). Only linear methods are allowed.
4	DRTCOF(NDIV)	+	Routing coefficient "X" for diversion. (See RT Record, Field 4).
5	DMUSK(NDIV)	+	Routing coefficient "K" for diversion. (See RT Record, Field 5).
6	DCON(NDIV)	0	One hundred percent of diversion flow is returned.
		+	Percentage of flow (expressed as a ratio) diverted from MM which returns at DRTTO(NDIV). A .2 indicates 20% of diversion returns.
7	KDTY(NDIV)	0	Diversion flow is **constant** and equal to DFLOW(NDIV) in Field 8.
		1	For **monthly** operations, 12 flow values on the QD Records would provide monthly diversions that would apply to each year's operation.
		-1[1]	Diversion quantity is a function of the **inflows** at control point MM according to the tables of CHQ (QS Records) and FDQ (QD Records).
		-2	Diversion quantity is a function of the reservoir **storage** for MM according to the tables of STOR (RS Records) and FDQ (RD Records).

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[1] Since these diversion types (DR.7, KDTY = -1 or -4) are not based upon fixed schedules, but are functions of flows or levels which are dependent upon upstream reservoir releases, simulations of complex systems which employ these diversions should be carefully reviewed to ascertain if the desired precision of operation is achieved. If increased precision in the operation of complicated water supply models is desired see J2.4 (code 32).

Field	Variable	Value	Description
		-3	Diversion quantity is a function of the **off-peak energy** available on the **PR**, **PD**, and **PH** Records for the dummy reservoir that represents a **pumped storage project**. Diversion (negative) is located at dummy reservoir just upstream of upstream generating plant. **Diversion is made from the dummy reservoir to the tailwater reservoir**. Diversion is limited by top of conservation pool or level LEVPUM(J1.7) at upstream project and by top of buffer pool (level 1 if power drawdown priority is used (J2.4)) of afterbay.
		-4[1]	Diversion quantities on the **QD** Record specify **monthly diversion** expected to arrive at the upstream location from a downstream (later in record sequence) location. This could represent a **pumping condition**.This option is similar to the pumped storage option (see KDTY = -3) in that negative diversions are specified at the upstream location (this control point) which diverts to the downstream location. If the upstream location is a reservoir, the diversions are limited by the top of conservation pool or level LEVPUM (see J1.7). If the downstream location is a reservoir, the diversions are limited by the top of buffer pool (or Level 1 if diversion priority IPRIO = 4 (J2.4)). If the downstream location is not a reservoir, the diversions are limited by the local inflow. For this option, a dummy reservoir is not required above the upstream diversion reservoir as is the case for pumped storage.
		-5	Diversions **vary by period** and are based on the QD Records which appear in the time series data (after the BF Record).
		-6	Diversion is equal to the **flow at the reference location** defined in Field 10 (see DR.10, IREFER). May be used with ratio specified in field 9.
8	DFLOW(NDIV)	0	Diversion flow is not constant.
		+	Diversion flow is **constant** and equal to DFLOW. Field 7 must be = 0.
9	DIVRAT	0	Ratio used is 1.0.
		+,-	**Ratio** which is multiplied times the diversion flows (RD, DR.8, QD Records).
10	IREFER	+	**Reference location** used in determining diversion using diversion type "-6" (see DR.7, KDTY=-6).

[1] Since these diversion types (DR.7, KDTY = -1 or -4) are not based upon fixed schedules, but are functions of flows or levels which are dependent upon upstream reservoir releases, simulations of complex systems which employ these diversions should be carefully reviewed to ascertain if the desired precision of operation is achieved. If increase precision in the operation of complicated water supply models is desired see J2.4 (code 32).

G.8.9 QS Record - River Discharges for Diversions, Variable Channel Capacity or Routing Options (optional)

QS Records are used with DR and QD Records to specify diversions which vary with flow in channel (diversion type -1); with CC Records for specification of variable channel capacities (channel capacity option 3); and with RT and SQ Records for specification of Modified Puls routing data (routing methods .3, .4 and .5).

For Modified Puls routing which varies as a function of inflow (RT.3 = .5) multiple sets of QS and SQ Records may be provided for up to six sets of storage and outflow data which are each a function of a given index inflow. For this method the maximum number of outflow values = 9. Also the storage outflow (QS-SQ) sets must be input in increasing magnitude of inflow and the first index inflow should be zero. The zero inflow set would be equivalent to the basic Modified Puls (RT.3=.3) which does not consider inflow.

Field	Variable	Value	Description
1	NPTSQ	2-18	Number of river discharges on QS Record. For use with diversion and variable channel capacity options (RT.3=.3).
		0,+	**Index inflow** for Modified Puls as a function of inflow (RT.3=.5). Maximum number of outflow values specified in fields 2 through 10 is nine values.
2-19	CHQ(M,N)	+	A table of river **outflows** in m^3/s (ft^3/s) at the downstream end of routing reach. Outflows correspond to the storages given on the SQ Records for use in non-linear flood routing from control point RTFR(M) (RT Record, field 1). NPTSQ values. Successive values should *increase*.

G.8.10 SQ Record - Channel Storages (optional)

Field	Variable	Value	Description
1	NPTSQ	2-18	Number of storage values on SQ Records (Must be same as NPTSQ on QS Record, field 1).
2-19	CHSTG(M,N)	+	A table of channel **storages** in 1000 m^3 (acre-feet). Storages correspond to the outflows given on the QS Records. Storage represents total volume between control point RTFR(M) and control point RTTO(M) (RT Record, fields 1 and 2). NPTSQ values.

G.8.11 QD Record - Diversion Flows for Diversion Types 1, -1, and -4 (optional)

Field	Variable	Value	Description
1	NUMDQ	+	Number of diversion values on QD Records for this control point. Maximum number = 18.
2-19	FDQ(M,N)	+	When KDTY (DR Record, field 7) = 1 or -4, these values represent the **monthly diversion** flows in m^3/s (ft^3/s). Twelve monthly values are given. The first value must correspond to January (ISTMO=1, J1.2).
"or"			
2-19	FDQ(M,N)	+	When KDTY (DR Record, field 7) = -1, Fields 2-10+ (up to 18 values) are the diversion flows corresponding to values of channel flow on the **QS Record**.

G.8.12 EL Record - Elevation or Stage for Non-reservoir Location (optional)

Field	Variable	Value	Description
1	NPTSQ	2-18	Number of elevation values (must be same as NPTSQ on QS Record, field 1).
2-19	EL(M,N)	+	Elevation or stage in meters (feet) corresponding to outflows given on QS Record. NPTSQ values.

G.8.13 C$ Record - Non-Reservoir Control Point (local project) Cost Data (optional)

Field	Variable	Value	Description
1	DESQ	0	Damages for the modified channel are reflected in the **second set of DC Records**.
		+	Design discharge (for the local project) below which there are no damages. Damages described on the DC Records will be eliminated below this discharge if one damage condition is provided. The channel capacity in Field 2 of the CP Record should be modified accordingly, but it can be different if desired.
2-19	COEF(N)	+	Capital (present worth) cost of the local project (channel modification, levee, floodwall, etc.) corresponding to the flows on the QS Record. The design discharge (DESQ) will be used as the reference level for discharge in determining the cost of the project from the QS and C$ Records.

G.8.14 CL Record - Reservoir Levels for Variable Channel Capacities (optional)

Optional record for specifying the reservoir levels corresponding to the channel capacity at location MM (CP.1). These reservoir levels correspond to location ILOCCC on the following CC Record, Field 1.

Field	Variable	Value	Description
1	NLEVS	1-18	Number of reservoir levels on this record. Maximum number of values = 18.
2-19	RLEVCC(M,K)	+	Reservoir levels corresponding to channel capacities on the next CC Record. NLEVS values in increasing order.

G.8.15 CC Record - Channel Capacity for Control Point (optional)

Optional record for varying the operational channel capacity at this location, **CP**.1, (either a reservoir or a control point). The channel capacity can vary monthly or by seasons or with the flow at any location; or it may be based on reservoir levels; or it may be based on seasonal guide curves; or be based on seasonal total system flood control storage. Maximum of two records per location. When this record is omitted, QMX (**CP** Record, field 2) is used for the channel capacity.

Operational Channel Capacity Options

Option	Description	Records Required[1]
1	Channel capacity is based on **month**.	CC
2	Channel capacity is based on **season**.	CC,CS
3	Channel capacity at this location is based on **flow** at another specified location.	CC,QS
4	Channel capacity at this location is based on **reservoir level** at specified reservoir.	CC,CL
5	Channel capacity at this location is a function of both **season** (time of year) and **level** (or **elevation**) at specified reservoir.	CC,CS,CG
6	Channel capacity at this location is a function of both **season** and percent of total **system flood control storage**.	CC,CS,GS,CG
7	Channel capacity at this location is a function of **rising** or **falling inflow** at specified reservoir.	CC

NOTE: CC Records can also be used in time series data (BF-EJ) to input period-by-period varying channel capacities.

Field	Variable	Value	Description
1	ILOCCC(MM) **.**OPTION	0.1	**OPTION 1**: Channel capacities are based on the **months** of the year. The number of channel capacities read is equal to 12 (two CC Records). The first channel capacity (Field 2) must correspond to January (ISTMO=1, J1.2).
		0.2	**OPTION 2**: Channel capacities are based on **season** of year (up to 18 seasons) using the CS Record to define the ending day of each season. Interpolations will be made for each time period of the simulation.

Continued on next page

[1] These records all appear at the current control point (CP.1) eventhough some locations reference data at another control point.

Field	Variable	Value	Description
		X.3	**OPTION 3**: Identification number (X) of control point used to obtain **inflows** that are compared with flows (read on the QS Records) for this location. Channel capacities corresponding to QS flows, start in Field 2.
		X.4	**OPTION 4**: Identification number (X) of reservoir (RL.1) whose **level** is used to compute the channel capacity based on CL Record data.
		X.41	Same as X.4 except use **previous period level** instead of forecasted level.
		X.5	**OPTION 5**: Identification number (X) of reservoir (RL.1) whose **level** (or **elevation**), from CG Record, and **season** (CS Record) will be used to compute the channel capacity.
		X.6	**OPTION 6**: Channel capacity at this location is a function of both **season** (CS Record) and total **system flood** control storage (CG Record) above location X. Location X can be a non-reservoir location. Also, see GS Record.
		X.7	**OPTION 7**: Identification number (X) of reservoir (RL.1) used to determine channel capacity as a function of **rising** or **falling** reservoir **inflow**.
2-13	CHCAPT(K)	+	**OPTION 1**: Twelve **monthly** channel capacities are specified, starting with January (ISTMO=1, J1.2).
"or"			
2-19	CHCAPT(K)	+	**OPTION 2**: Up to 18 channel capacities are specified, corresponding to the **seasons** shown on the CS Record.
"or"			
2-19	CHCAPT(K)	+	**OPTION 3:** Channel capacities on this record(s) correspond to **inflows** at location ILOCCC(MM) based on the QS Record flow values for this location. Interpolated values of the channel capacity will be used as the flood hydrograph progresses, except that the channel capacity is never decreased until the current inflow is less than the first inflow. Thus, once the maximum regulated discharge is reached, the corresponding channel capacity is maintained. Number of channel capacities read is NPSTQ (QS.1). Maximum number of values = 18. **OPTION 4**: Channel capacities on this record(s) correspond to the reservoir **levels** on the CL Record for location ILOCCC(MM) ("X part" of CC Record, field 1). Interpolations are made for channel capacities between values on these records. NLEVS (CL.1) values. Maximum of number of values = 18.

Field	Variable	Value	Description
"or"			
2-19	CHCAPT(K)	+	**OPTION 5**: Channel capacities on this record (in increasing order) correspond to the reservoir **levels or elevations** on the CG Records for location ILOCCC(MM) and **seasons** on the CS Record. A maximum of 18 channel capacities may be used.
"or"			
2-19	CHCAPT(K)	+	**OPTION 6**: Channel capacities on this record (in increasing order) corresponding to the percent of **reservoir system flood control storage** based on the CG Record for location ILOCCC(MM) and **seasons** on the CS Record. A maximum of 18 channel capacities may be used.
"or"			
2-4	CHCAPT(K)	+	**OPTION 7**: The channel capacity in field 2 of this CC Record is used when **reservoir inflows** at location ILOCCC(MM) are **rising**. The channel capacity in field 3 is used when **reservoir inflows** are **falling**. Optional value in field 4 is required change in reservoir inflow (m^3/s (ft^3/s) per period) necessary to trigger the change from rising to falling (or visa versa) channel capacity.

G.8.16 CS Record - Seasons for Variable Channel Capacities or Reservoir Levels (optional)

Field	Variable	Value	Description
1	NSEA	+	Number of seasons to be read on this record as well as on each CG Record and/or RL Record. A maximum of 36 seasons can be used in conjunction with RL, CG, or QM Records, and a maximum of 18 is permitted for use with the CC Record.
2-19	CGSEA(MM,IS)	+	Cumulative number of days from the beginning of the calendar year for each season (IS) that will correspond to each value specified on CG Records and/or RL Records for location MM. The last value must be = 365.

G.8.17 GS Record - System Flood Control Guide Curve Specification Record (optional)[1]

Optional record used with CC Record channel capacity (Option 6) for location MM (CP.1) to specify certain parameters concerning the guide curve (CG Records) for a flood control system. Only one GS Record can be used in the basin and MM must be at a non-reservoir location that is downstream from flood control projects which are to be used in calculating the percent of flood control storage in the system. Values given on the CG Record are **percent flood control storage** (instead of elevation or reservoir level).

Field	Variable	Value	Description
1	GCFCST	0	IFCAST (J2.1) hours will be used.
		+	Number of hours into the future when the percent of flood control storage will be calculated.
2	GCSYFC	0	The system flood control storage will be based on summing the flood control storage in all reservoirs that are located above MM.
		+	The system flood control storage in 1000's m^3 (acre-feet), which is used to calculate the percent of system flood control storage. Used as a parameter with the CG Record data for location MM (percent is used instead of level or elevation).
3	GCSYSQ	0	Reservoir release for system evacuation for future periods (GCFCST) will be based on the sum of the channel capacities for all reservoirs that release directly (not through other reservoirs) to location MM.
		+	Sum of reservoir releases (in m^3/s or ft^3/s) representing the expected system releases during the forecasted period (GCFCST).
4	GCSYMT	0	Equation 2 will be used.
		1 or 2	Equation number for calculating the percent of system flood control storage above location MM at time GCFCST into the future. Equations are as follows: EQ1 = (100./GCSYFC) * (SUMS+SUMIO) EQ2 = (100./GCSYFC) * (SUMS+SUMIOA) where: SUMS = sum of flood control storage used for current time period (no negatives) in all upstream reservoirs above MM. SUMIO = sum of inflows less sum of reservoir releases expected in next GCFCST hours converted to m^3 (acre-feet). SUMIOA = sum of inflows less GCSYSQ releases in next GCFCST hours converted to m^3 (acre-feet).

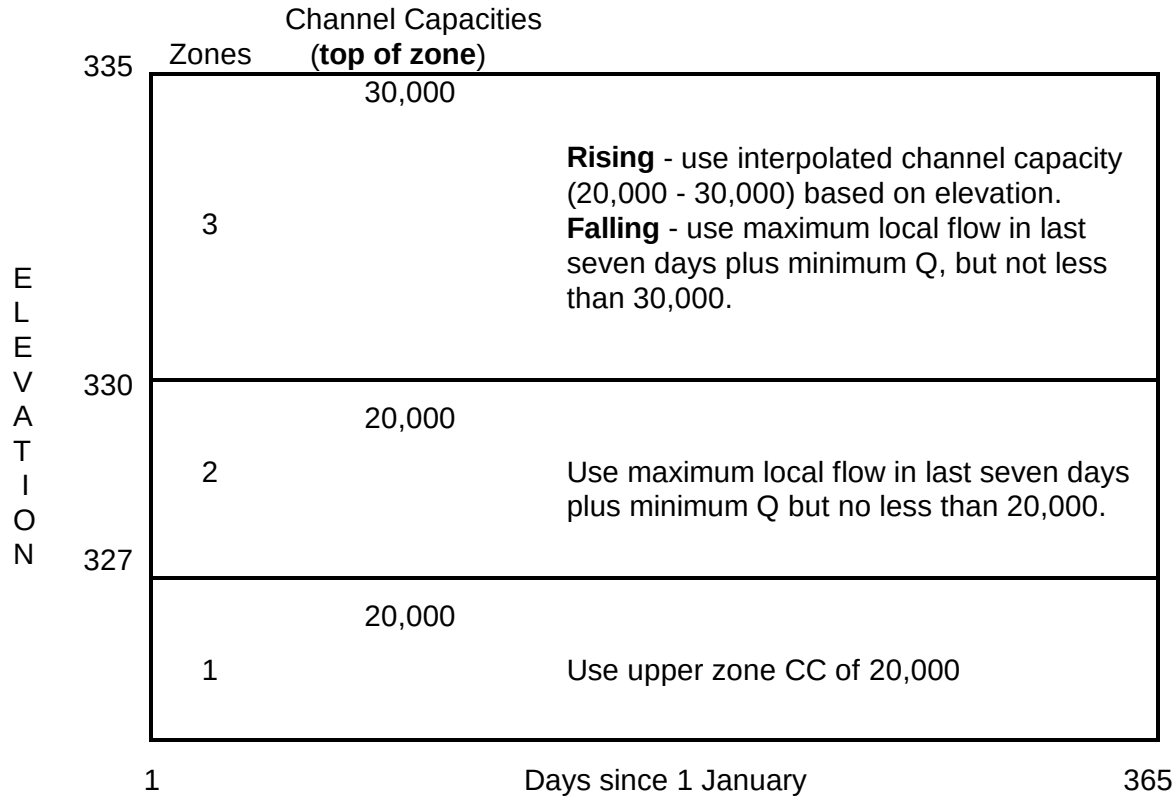
[1] GS Record follows the CS Record and precedes the CG Records. These Records plus CC Record (Option 6) are required if a GS Record is used.

G.8.18 CG Record - Seasonal Guide Curve for Channel Capacities or Minimum Flows Using CC Record (Options 5 and 6) or QM Record (-LOC Option) (optional)

Discussion: The operational channel capacity for flood control that can vary seasonally with reservoir level or elevation represents a rule curve operation. The rule curve describes the operational channel capacity within various seasonally varying elevation (or level) ranges called zones. Within each elevation zone, the criteria for the operational channel capacity can be specified differently for rising and falling reservoir stages. A zone is defined as the area between two adjacent channel capacities. The code X applies to the zone represented by the current channel capacity and the previous channel capacity (if any). A value of -0.2000 for the first **CG** Record would represent using 2000 m^3/s (ft^3/s) for all elevations below the elevations on this **CG** Record corresponding to the season on the **CS** Record.

Example:

Sample Rule Curve of Augusta, Georgia (Location 303)



HEC-5 Channel Capacity Data for Augusta Rule Curve (Location 303)

```
CC      303.5      20000      20000    30000
CS          1        365
CG     -404.1        327
CG     -707.2        330
CG     -207.3        335
```

A **CG** Record is required for each channel capacity specified on the **CC** Record, up to 18 seasonal values, in order to specify the guide curve for that capacity. If more than 9 seasons are specified on the **CS** Records, two **CG** Records are required for each channel capacity. The **CG** Records are arranged in the same order as the channel capacities on the **CC** Record.

Field	Variable	Description
1	CGVAR(IC,MX)	This code describes the method to be used in determining the channel capacity (or minimum flow if QM Record is used instead of CC Record) within the reservoir zones. The X value (to the left of the decimal) represents a code to describe the method. Reservoir levels (see J1 Record) are used as the parameter on this record starting in Field 2 unless Field 1 is **negative**, and then elevations are used. The parameter is percent flood control storage if GS Record is used for this location instead of elevation or level. The Y value (to the right of the decimal) is not used by the program but is available to reference the channel capacity (IC) (or minimum flow) corresponding to the reservoir (MX) data on the current CG Record. A suitable reference number might be the channel capacity expressed as a decimal (e.g., divided by 1,000 or 10,000), or perhaps the CC Record field number in which the channel capacity is specified. The codes for the X values are as follows:

Code[1,2]	**Method of Determination**
X = 1	Channel capacity for a reservoir level (or elevation) within a zone is the capacity associated with the level (or elevation) specified for the **bottom of the zone**.

Continued on next page

[1] A single digit entry represents criteria for both **rising** and **falling** reservoir levels. If desired, specify different rising and falling criteria for a zone using a compound code as follows: 201 represents code 2 for rising and code 1 for falling.

[2] For the first CG Record, codes of 1, 2, or 3 should not be used since there is no data for the previous zone.

Field	Variable	Description

Code	Method of Determination
X = 2	Channel capacity for a reservoir level (or elevation) within a zone is obtained by **linear interpolation** between the levels (or elevations) specified for the top and bottom of the zones.
X = 3	Channel capacity for a reservoir level (or elevation) within a zone is the **arithmetic average of values specified** for the top and bottom of the zone.
X = 4	Channel capacity for a reservoir level (or elevation) within a zone is the capacity associated with the level (or elevation) specified for the **top of the zone**.
X = 5	Channel capacity is equal to the **maximum regulated** flow that has occurred at this location during the **last seven days**. However, the channel capacity is constrained to **not exceed** the capacity associated with the **top** of the zone, or to be less than the capacity associated with the bottom of the zone.
X = 6	Channel capacity is equal to the **maximum regulated** flow that has occurred at this location during the **last seven days**. However, channel capacity will **not be less** than the channel capacity at the **top** of the zone.
X = 7[3]	Channel capacity is equal to the **maximum local flow** (plus minimum flow) that has occurred at this location during the **last seven days**. However, channel capacity will **not be less** than the channel capacity at the **top** of the zone.
X = 8	Channel capacity (or minimum flow on QM Record varies with CG Record) for the current period will be based on the **minimum elevation** (or level) **experienced** prior to the current period (instead of the current period) if this option is used. For example, a code of 802 or 208 would cause the program to use a linear interpolation (X=2) of the values between the top and bottom of the zones based on the maximum drawdown level experienced prior to the current period.

[3] Minimum flow will be added to **maximum local** flow to determine channel capacity only if IPRIO (J2.4) contains codes 1 or 8.

Field	Variable	Description
2-19[4]	CGUIDE(IS,IC,MM)	If Field 1 is **positive**, specify reservoir **levels** for reservoir location (MM) shown on Field 1 of CC Record corresponding to the channel capacity (IC) on the CC Record for season (IS) on the CS Record. Specify NSEA (CS.1) values. Maximum = 18 values if CC/CS Records are used; maximum = 36 values if CS/QM Records are used. If Field 1 is **negative**, specify reservoir **elevations** for reservoir location (MM) shown on Field 1 of CC Record corresponding to the channel capacity (IC) on the CC Record for season (IS) on the CS Record. Specify NSEA (CS.1) values. Maximum = 18 values if CC/CS Records are used; maximum = 36 values if CS/QM Records are used. If **GS** Record is used, specify **percent** of system flood control storage above location ILOCCC on Field 1 of CC Record corresponding to the channel capacity (IC) on the CC Record for season (IS) on the CS Record. Specify NSEA (CS.1) values. Maximum = 18 values if CC/CS Records are used; maximum = 36 values if CS/QM Records are used.

[4] Even though the description of the CG Record primarily discusses channel capacities, the CS/CG/QM Records can be used for specifying seasonally varying minimum flow goals based on guide curves. If the QM Record is used (instead of the CC Record), then up to 36 values can be specified (fields 2-37).

G.8.19 QM Record - Minimum Desired Flows Which Vary Monthly (optional)[1]

Field	Variable	Value	Description
1-12	COEF(I)	+	Minimum desired **monthly** flow goals for control point MM for 12 periods. The first monthly value must correspond to January (ISTMO=1, J1.2). If semi-monthly flows are used, enter 24 values.
"or"			
1-36	COEF(I)	+	Minimum desired flow goals for control point MM vary by **seasons** (CS Record). Maximum number of values = 36.
"or"			
1	COEF(1)	**-**LOC	Minimum **desired** flow goal for control point MM varies with the Reservoir (LOC) elevation or level (as shown on **CG Record** for location MM) and season (**CS Record** for location MM). If this option is used for location MM, the channel capacity for location MM cannot vary with the CG Record (see CC Record description). A dummy control point can be added if both minimum flows and channel capacities vary with reservoir level.
2-21	COEF(I)	+	Minimum desired flows at this location (in increasing order) corresponding to the reservoir levels or elevations on the CG Record for location, LOC, and seasons on the CS Record. A maximum of 20 values can be used. One QM Record may be used if there are 9 or less minimum flows given.

[1] QM Records are assumed applicable to all events (time series data sets: BF through EJ Records). MR Records (period-by-period varying minimum desired flows input following the BF Record) are not required for short interval simulation periods if flows still vary monthly; but if MR Records are used for any event, they will override the monthly QM Record data for that event only.

G.8.20 WA Record - Water Allocation based on Natural Flows and Reservoir Level (optional)

Optional record to define a **Minimum Desired** flow sequence as a **ratio of natural flows** at a **non-reservoir** location. The ratio selected is a function of both the seasonal volume of natural runoff and the status of a reference reservoir.

The ratio, WARAT1 (input in the second field), is used to derive the minimum desired flow sequence, unless the annual natural runoff volume exceeds the specified test volume WAVOL (input in the fifth field) and either of the following conditions occur at the reference reservoir:

CONDITION 1: On the specified date, the elevation of the reference reservoir is **greater than** test elevation 1 (WAELE1);

"or"

CONDITION 2: On the specified date, the elevation of the reference reservoir is **less than** test elevation 1 (WAELE1) but **greater than** test elevation 2 (WAELE2) "and" since the last occurrence of an elevation equal to or greater than the test elevation 1(WAELE1), the reservoir has not had an elevation less that test elevation 2 (WAELE2) on the specified date.

When either of the two volume-elevation conditions occur, the second ratio (WARAT2) will be used to derive the minimum desired flow sequence.

This record is input following the CP-QM Records. **Calculation of natural flows** (J3.4=-1) **must also be specified** when using this option. When this option is used, the volume of natural flow (1000 m^3 or acre-feet) is output in an user defined table and/or written to HEC-DSS by the specification of code .22 on the **J8**/**JZ** Records.

Field	Variable	Value	Description
1	IWARES	+	The location number of the reference reservoir used in determining which of the two ratios will be selected to compute the minimum desired flow sequence.
2	WARAT1	+	First of two alternative ratios used in deriving the minimum desired flow sequence from natural flow.
3	WARAT2	+	Second ratio used in deriving minimum desired flow sequence.
4	IWAVOL	1-365	Julian date for the summation and testing of natural runoff volume (e.g. June 1 = 152)
5	WAVOL	+	Natural runoff test volume (1000 m^3 or acre-feet) determined on Julian date IWAVOL.
6	IWAELE	1-365	Julian date for testing elevation criteria at reference reservoir.
7	WAELE1	+	Test elevation 1 for reference reservoir.
8	WAELE2	+	Test elevation 2 for reference reservoir.
9	WAELE3	+	Initial value of past minimum IWAELE elevation (for Condition 2 check at the start of a simulation).
10	IWASUM	1-365	Julian date to start summation of annual natural flow volume.

Application Example:

The following records example the application of the **Water Allocation** option to derive a sequence of minimum desired flows based on natural runoff. In this example, the location where minimum desired flow sequence is being derived is location 11; the reference reservoir location is 83; the two ratios are 0.5 and 0.4; the date to determine the volume of runoff is June 1; the test runoff volume is 40,500 ac. ft.; the date to check the reference reservoir elevation is June 1; the test elevations are 1594.8, 1593.8, and 1594.4; and, the date to start the summation of natural flows is January 1.

```
CP    11    9999
ID CP11
RT    11      22
WA    83      .5      .4     152   40500     152 1594.8 1593.8 1594.4   1
```

G.9 Control Point Records for Damage Data

Evaluation can be made of the damages that would result from a single flood or a series of floods. In addition, the expected value of annual damages (average annual damages) can be determined. The evaluation is made for base conditions, regulated conditions, and for conditions resulting from uncontrolled local flows below the reservoirs. Damages can be a unique function of peak flow rate or include a maximum of five different durations. Damages can also be defined for a maximum of seven seasons within the year. Damages are computed at each damage center and for the basin as a whole. Total damage for a single flood or a series of floods can be evaluated. However, when the expected value of annual damages is computed, at least six floods representing the full range of expected discharges should be processed. The BF and FC Records control the number of floods[1] to be processed, and the J4 Record, Field 1, provides the damage computation option. The DA, DF, DQ, and DC Records describe the frequency, flow, and damage data required for each control point (either reservoir or non-reservoir).

If damages are not to be evaluated, all DA-DC Records are omitted.

[1] For damage calculations based on season and duration, a maximum of 10 floods may be used.

G.9.1 DA Record - Damages (Expected-Annual) for Base Conditions (optional)[1]

Field	Variable	Value	Description
1	J	1 to 9	Number of damage categories to be read on this record (maximum of 9). DC Records (1 or 2 sets) will be read for each of these categories for each season and for each duration.
		-1 to -9	Same as + except that damages on DC Record are functions of stage or elevation (for reservoir) instead of discharge. Stages are given on DQ Record instead of discharges. QS and EL Records must also be used to describe the stage-discharge relationship at non-reservoir control points. At reservoirs, RE Records are required to describe the elevation in the reservoir. QS and EL Records cannot be used at reservoirs.
2-10	COEF	0	Expected annual damages for base conditions are not given. The damages for base conditions will be computed from the input flow-damage-frequency functions and used in adjusting the integration procedure for the modified conditions as discussed below.
		+	Expected annual damage for base conditions for each of (J) damage categories.

NOTE: Records DA-DC can be omitted if damage data will be calculated by routines available through random access storage (HEC-DSS).

[1] When DA Record is read, all other damage records (except DB) are required.

G.9.2 DB Record - Base Damage Record for Existing System (optional)

The DB Record may be used to input the expected annual damage for each damage category for an existing reservoir system. These expected damages are then substituted for expected damages for the base condition so that the incremental reduction due to additions to the existing system can be displayed.

Field	Variable	Value	Description
1	J	1-9	Number of damage categories on the DA and DB Records.
2-10	COEF	+	Expected annual damage for each damage category in turn for this control point for existing reservoirs and other developments (base conditions). Base condition damage data (see DC.2) are not provided if this option is used.

G.9.3 DF Record - Damage Frequencies (optional)[1]

Field	Variable	Value	Description
1	K	1-19	Number of values of exceedance probabilities on this DF Record which will correspond to discharge values on DQ Record and damages on DC Records. Maximum of 19 values.
2-20	COEF	+	Exceedance probabilities (in order of decreasing magnitude, i.e., .99, .95, etc.) from a frequency curve for each value of discharge on the DQ Record. Values can be annual series or partial duration.

G.9.4 DQ Record - Damage Discharge or Stage/Elevation (optional)[1]

Field	Variable	Value	Description
1	K	1-19	Same as DF Record, Field 1.
2-20	COEF	+	Discharges (K values) corresponding to the exceedance probabilities on the DF Record. These discharges must be in increasing order of magnitude. Discharge values should be average values for the time interval used (IPER, BF.7). Stages or elevation (for reservoirs) if J is negative (DA.1). These data must be in increasing order of magnitude.

[1] When DA Record is read, all other damage records (except DB) are required.

G.9.5 DC Record - Damage for Each Category (optional)[1]

Base condition damages for each damage category (J from DA Record, Field 1). X sets for each damage category, where X = number of seasons used (1-7) times the number of durations used (1-5). "J" sets of additional DC Records may be used if one represents base conditions and the second represents modified conditions from channel improvement or land purchase, etc.

Field	Variable	Record Column	Value	Description
1[2]	ID	1-2	DC	Identification letters.
	CAT	3	1-9	Damage category (maximum of 9).
	SEA[3]	4-6	0-365	End of current season in days for damages on this DC Record. (Jan 1 = 1.) A maximum of 7 seasons may be used.
	DUR	7-8	0-99	Duration in days for current damages on this DC Record. A maximum of 5 durations may be used.
2-10	COEF		-	Factor which is multiplied times all damage values on previous DC Records to obtain damages for this category, season and duration. Fields 3-10 of this record are ignored, and a second DC Record for this category, season and duration will **not** be read.
			+	Damage in dollars or multiples thereof corresponding to the same fields of the DF and DQ Records and for damage category N. All damages on these records will be multiplied by ECFCT (Field 2 of J4 Record) to obtain the damages in dollars. K(DQ.1) values on each set of records. J(DA.1) sets of DC Records are used for base conditions, and J additional sets may be used for modified conditions. Input for the J additional sets would follow the complete input for the base condition.

[1] When a DA Record is read, all other damage records (except DB) are required.

[2] Field 1 is optional if DC Records for only one season and duration are used.

[3] Maximum of ten floods may be used for seasonal damages.

G.10 End of Control Point Data

G.10.1 ED Record - End of Control Point Data (required)

Required record at end of last set of control point data records (CP - DC) and just before BF Record for first event.

Field	Variable	Value	Description
1-10			Not used.

G.11 Specification for Time Series Data Records

Data records after the ED Record represent time series data. Data for each flow data set are bounded by a BF and an EJ Record. For any set of flow data, the set is preceded by a single BF Record. A single FC Record and/or one or more SS and/or ZR or ZW Records may follow the BF Record. These records may be followed by a set of IN Records for each control point in the system where inflows are to be specified. Omitted flow data for control points will be assumed as zero unless computed by a ratio of another location (see C1.1). The order of the time series records (IN, QA, NQ, etc.) is not important.

HEC-DSS

HEC has developed a data storage system (HEC-DSS) and a set of utility programs to interact with HEC-DSS to facilitate analysis of water resource time series data. HEC-DSS stores data in elemental blocks or records representing convenient groups of sequential data or pairs of data defining a relationship. The utility programs that have been developed act as interfaces between HEC's generalized application programs such as HEC-5 and HEC-1 and HEC-DSS.

Data stored in HEC-DSS may be plotted or tabulated using the DSPLAY program, or used by other programs for a subsequent analysis (e.g. STATS). Time series data to be input to HEC-5 (e.g., flows) can be entered into a DSS file using programs such as WAT2DSS (WATSTORE to DSS) and DSSIN or DSSTS. Program DSSUTL performs utility functions (editing data, renaming records, etc.) while program DSSMATH can mathematically manipulate the data stored in HEC-DSS.

HEC-DSS uses "pathnames" to identify data stored in a DSS file. For time series data, information is organized into blocks of data, each block containing data at one location, for one variable over a specific period of time (e.g., 1 month or 1 year). The pathname used to identify the block is divided into six parts, each part separated by a slash "/". The first or the "A part" corresponds to the basin or project name (see example below). The second or "B part" is the location name for the data. The "C part" identifies the data variable (e.g., FLOW, ELEV, etc.). The "D part" gives the beginning date of the time block, the "E part" gives the time interval between data (e.g., 1DAY), and the "F part" is for any additional qualifications needed that the user might want to supply (plan labels are a good example of what the "F part" may contain).

Sample Pathname:

/RED RIVER/DAVIS/FLOW/01JAN1981/1DAY/PLAN 3A/

When specifying pathname parts on ZW and ZR Records, each part is given in free format style, with commas or blanks separating the parts. A pathname part may have embedded blanks, but no leading or trailing blanks.

Writing to DSS

Writing to HEC-DSS by HEC-5 is controlled by **JZ**, **ZW**, **ID**, and **BF** Records. The presence of a ZW Record will cause HEC-5 to write to DSS. When writing data generated by HEC-5 to a DSS file, a ZW Record is required in the input following each BF Record. The A and F parts of the pathname are specified on the ZW Record in a free format style. An example which would write data to DSS is:

```
ZW  A=RED RIVER, F=PLAN 3A
```

The A and F parts are the only pathname parts that need to be specified on the ZW Record. The B part of the pathname is obtained from the ID Record. The C part is provided by the program based on the variables (default or specified on JZ Record) to be written. The D and E parts are determined by the program from the time parameters on the BF Record. Specific control point locations and data variables to be stored may be specified on the JZ Record.

Reading from DSS

The access of time series data from an HEC-DSS file is controlled by ZR, ID, and BF Records. Field 1 of the BF Record must always be set to 2 when reading from DSS. Data stored in a HEC-DSS file are read by HEC-5 using a ZR Record. The ZR Record, which follows the BF Record for each flood, indicates which data is to be read from DSS. The A, C and F parts of the pathnames for the data to be read are specified on the ZR Records. The type of HEC-5 time series input data (i.e., IN, QA) must also be specified in the ZR Record. Similar to the ZW Record, these pathname parts are given in a free format form. For example:

```
ZR=IN  A=RED RIVER, C=FLOW, F=OBS
```

This would cause IN time series data to be read from DSS for all control points in lieu of the user supplied IN Records. The A and the F parts, defined on the first ZR Record, remain the same until reset by a later ZR Record.

The B part of the pathname is obtained from Fields 3 and 4 of the ID Record, unless blank, whereby Fields 1 and 2 are used. The D and E parts are generated using the time parameters given on the BF Record. If data is missing from the DSS file at the beginning or end of the requested time period, the first or last data value is repeated and extended to replace the missing data and a warning message is printed. If data is missing in the middle of a data block, the missing data is assigned the value of the last valid period. If no data exists, a warning message is printed and no data is read into HEC-5. Data is attempted to be read for each relevant control point, unless ZR Records restrict the reading to specific control points.

The specific control point form of the ZR Record allows the user to read data for only the specific control point indicated on the record using pathname parts different from the default parts. The B part of the pathname may be given if different than the name given on the ID Record. The A, B, C, and F parts given on the specific control point form of the ZR Record do not become defaults for later ZR Records, they are only used for processing that record. If specific control point ZR Records are used in conjunction with a global ZR Record, global parts are used for any parts not given on the specific record. For example:

```
field = (1)   (2)                    (5)              (7)          (10)
BF      2     365                 59010100            24          1900
ZR=IN      A=RED RIVER         C=FLOW       F=OBSERVED
ZR=IN25          B=DRY CAMP                    F=PLAN3A
ZR=IN42          B=BRIDGE PORT    C=FLOW-NAT
EJ
```

These records will cause one year of daily inflow data (starting on January 1, 1959) to be read at every control point using the parts given on the first ZR Record, except at control point 25, where an F part of "PLAN3A" will be used, and at control point 42 where a B part of "BRIDGE PORT" and C part of "FLOW-NAT" will be used (F part will be OBSERVED as given on the "global" ZR Record).

If data is to be read for only certain control points, specific ZR Records are used. For this method, the A, C, and F parts are set on the ZR Record for the specific control point (the B part is optional if same as the name given on the ID Record). For example:

```
field =(1)        (2)               (5)              (7)                 (10)
BF      2          24             64010100            720                1900
ZR=IN32         A=RED RIVER     B=FARMTOWN       C=FLOW       F=OBSERVED
ZR=IN105        A=RED RIVER     B=WHEATLAND      C=FLOW       F=OBSERVED
IN     25
IN   1875       1950    1475     890     510     330         320     285      270      310
IN   1300       1540    1975    2110    1710     980         620     430      310      280
IN    265        360    1120    1550
EJ
```

The above example will cause two years of monthly data (starting on January 1, 1964) to be read from HEC-DSS for only control points 32 and 105. This method should be used when reading from both DSS and user-supplied time series records or when C1 Records are used to specify inflows. Flow data in this example for control point 25 is entered on IN Records.

The names of the HEC-DSS file(s) to be used are specified on the execution line of the program HEC-5A. If data is to be read from and written to the same file, the word "DSSFILE" should be used. If data is to be read from one file and written to another the words "DSSIN" and "DSSOUT" should be used. For example:

HEC5A,INPUT=SCIN.DAT,DSSFILE=SCIDSS.DSS

"or"

HEC5A,INPUT=SCIN.DAT,DSSIN=SCIOBS.DSS,DSSOUT=SCIPLAN.DSS

For flow-frequency data, the "DSSFILE" must be specified on the execution line of HEC-5B as shown in the following example:

HEC5A, INPUT=SCIN.DAT, OUTPUT=SC.OUT,DSSFILE=SC.DSS

HEC5B, OUTPUT=SC.OUT, DSSFILE=SC.DSS

G.11.1 BF Record - Beginning of Flood (time series data set) (required for each flow data set)

Field	Variable	Value	Description
1	FLOFMT	2	All time series data (Records IN-ST) will be read using the standard format of 10 fields per record. For each set of data, the location identification number (LOC) is read on the first record and the data values are read starting with the first field of the second record. If the third field of the first time series data record is greater than zero, it will be used as a multiplier for all time series data on remaining records of the set. Fields 4-10 of the first record of the set are not used.
		0,1	Obsolete data formats.
2	NPER	+	The number of periods of flow data on next set of records (IN-ST). Maximum value = 2000[1].
3	NPSTO	0	Reservoir storages are not transferred to the next event (also referred to as floods or flow data sets or time series data sets). These sets are defined by BF and EJ Records.
		+	Time period of this time series data set for which reservoir storage will be transferred to the next time series data set (next BF-EJ data set). This is normally set equal to NPER less IFCAST(J2.1). When a monthly operation follows a short interval event, NPSTO must equal NPER.
4	CNSTI	0	Flow data will not be multiplied.
		+	Factor which is multiplied times all inflows and local flows on the next IN and NQ Records.
5	FLDAT	+	Date corresponding to the **beginning of the time interval** of the first flow on the next IN Record. The date is an 8 digit number (2 digits each for year, month, day, hour) such as 54120223 for December 2, 1954 at 11 p.m. For monthly simulation intervals the day should be = 01, and the hour = 00. For daily the hour = 00.
6	EPER	0	Last computation period will be NPER (BF.2).
		+	Last computation period of simulation (must be less than NPER, BF.2). Typically, not used but may be useful when debugging. Can be used within the first BF-EJ data set only.

[1] If more than 2000 periods are needed for an HEC-5 model, then multiple events (BF-EJ) can be used and storages transferred (BF.3) between events. Maximum of 80 events (BF-EJ sets).

Field	Variable	Value	Description
7	IPER.MINPER	+	Time interval in hours (IPER) **or** minutes (MINPER) between data in all time series data records (i.e., IN, QA, etc.). For intervals of one hour or longer use integer values of IPER (i.e., 24 for a daily interval, 720 for a monthly interval, 240 for 3 intervals per month, and 360 for 2 intervals per month). For intervals of 60 minutes or less use a **decimal point** followed by the number of minutes (i.e., for a half-hour interval use .30, for a 15 minute interval use .15). Where power reservoirs are used, interval must be equal to 1 hour or more.
8			"No longer used" for specifying day of week since program determines day of week based on field 5 (FLDAT).
9	ONESUM	0	Output summaries will be based on time periods designated by input data (BF-EJ Records) unless NPER(BF.2) exceeds 365, and IPER(BF.7) = 24 hours. In this case, the individual flood events (BF-EJ) will be combined into a continuous string of output so that 50 years of daily data will be summarized as one flood event.
		1	A single flood summary will be used regardless of values of NPER and IPER for the individual floods.
		2	The output summary will correspond to the input flood periods (BF-EJ Records) regardless of the values of NPER and IPER.
10	ICENT	+	Integer number for century of year in FLDAT (eg. 1800).
		0	Integer number for century of year in FLDAT (BF.5) defaults to 1900.

G.11.2 FC Record - Flood Ratios (optional)

Field	Variable	Value	Description
1-10	CNSTI	+	Ratios to multiply next set of flow data (IN Records) by to obtain additional system operations. A maximum of 10 values are read. The program will make a complete operation for each ratio of the given flow data. One of the CNSTI values should be 1.0 if given flow data is to be one of the events.

G.11.3 SS Record - Starting Storages (optional)[1]

Field	Variable	Value	Description
1	MM	+	Identification number (RL.1) of reservoir whose starting storage is in Field 2 of this record.
2	STOR1(M)	+	Starting **storage** for reservoir MM at beginning of event (see FLDAT, BF Record, field 5).[2]
		-	Starting **elevation** for reservoir MM at beginning of event (see FLDAT, BF Record, field 5).

[1] These starting storages will override those on the RL or R1 Record and can be specified for any or all reservoirs by using an SS Record for each reservoir. SS Records may be used for any or all floods by inserting them after the appropriate BF Records.

[2] A ZR Record, (ZR=SS) when used, will read in starting storages from HEC-DSS.

G.11.4 ZR Record - Identification Record for Reading Data from HEC-DSS (optional)

Read time series data from HEC-DSS (see Section G.10, page 90 for additional description).

Record Columns	Variable	Value	Description
1-2	ID	ZR	Record identification characters.
3-5	Data type	Blank	When this field is blank the ZR Record is only used to set the default A and F parts for subsequent ZR Records.
		=Data Type	An equal sign and the HEC-5 time series record 2-letter identification characters indicating what data type is to be read from HEC-DSS (i.e., =IN, =QA, =SS, or =NQ).
6-8	MM	Blank	When no control point number is specified, data will be read for all control points defined in the HEC-5 data input that require the type of data specified in columns 3-5.
		+	Up to 3-digit “left justified” location number (as defined on CP Record, field 1), causes data for only that location to be read from HEC-DSS. Any pathname parts appearing on this record will be used only for this current record and will not reset the default values for subsequent pathname parts.
10-80	Pathname Parts		Free form identification of pathname parts. Each pathname part is separated by a comma or space. Unspecified pathname parts will assume default values specified on previous ZR Records, except as noted for specific locations above. Examples: ZR=IN A=RED RIVER, C=FLOW-LOC INC, F=PLAN A ZR=IN25 B=BOGGY CREEK, C=FLOW-REG, F=PLAN E ZR=QA C=FLOW-RESOUT, F=PLAN C

G.11.5 ZW Record - Identification Record for Writing to HEC-DSS (optional)

Write data to HEC-DSS. See Section 11 (page 96) for additional description. Locations and variables to be written to HEC-DSS are controlled by the **JZ** Record(s).

Record Columns	Variable	Value	Description
1-2	ID	ZW	Record identification characters.
3-4		Blank	Time series data will be written to HEC-DSS. If Field 10 of the J4 Record is set, flow-exceedance frequency data will also be written to HEC-DSS.
		QF	Only flow-exceedance frequency data will be written to HEC-DSS (the tenth field of the J4 Record must be set for this option).
5+	Pathname Part		Free form identification for A and F parts of the pathname. When writing flow-exceedance frequency curves (J4.10 = 1 or 2) specify E part of pathname. Each pathname part is separated from other parts by either a space or a comma. Examples: ZW A=RED RIVER F=PLAN 6C ZWQF A=RED RIVER E=1970 F=PLAN 7

G.12 Time Series Data Records

These time series data represent all data that vary with time according to the specifications given on the preceding BF Record.

Standard Time Series Data Format Example

With the standard time series data format (BF.1=2), the first record (IN-ST) in a sequence specifies the location number for the data. Each subsequent data record of the series contains 10 values except for the last record which may have less than 10 values. In the following example 28 months of flow data (starting in January 1, 1964) are specified for location 25.

```
BF     2      28                64010100             720                    1900
IN    25
IN  1875    1950    1475     890     510     330     320     285     270     310
IN  1300    1540    1975    2110    1710     980     620     430     310     280
IN   265     360    1120    1400    1400    1400    1400    1400
EJ
```

Abbreviated Time Series Record Format

An abbreviated flow format is available that requires one record image to specify up to 5 consecutive flows starting with the input starting time period. Multiple record images can be used to specify other periods. All flows not specified by these records are assumed to be equal to zero. This abbreviated format is:

Field	Variable	Value	Description
1	LOC	+	**Location** identification number of control point
2	IDAT	-	Starting period number (**negative**) for flow or code value in field 6
3	MULT	+	**Multiplier** (default = 1.0) times flow values in fields 6-10
4	CONST	+	**Constant** (default = 0) which is added to flow values in fields 6-10.
5	IREP	0	Last flow value will not be repeated.
		+	Number of periods that last flow or code value will be **repeated**.
		-	Same as +, except product of flows and "MULT" will be truncated and added to "CONST."
		-999	Last flow will not be repeated, but product of flows and "MULT" will be truncated and added to "CONST ".
6-10	QTC	+	Up to 5 consecutive **flow** or **code** values starting at time period IDAT (field 2). The flow values will be multiplied by "MULT" and "CONST " will be added.

Abbreviated Time Series Data Format Example:

With the abbreviated format, each record specifies both the location and the starting time (period number) of the data. In the following example, the 28 flow values for location 25 are entered on 6 records. The flow data for periods 24-28 are entered with a single value (1400 for period 24) and the notation that 1400 will be “repeated” **4 more** periods (25-28).

The single QA Record in the data set directs Reservoir 25 to make releases of 1250, 1000, and 750 during periods 15-17. In all other periods (1-14 and 18-28) the program will determine releases for Reservoir 25.

```
BF      2      28                64010100             720                          1900
C
IN     25      -1        0       0        0    1875    1950    1475      890       510
IN     25      -6        0       0        0     330     320     285      270       310
IN     25     -11        0       0        0    1300    1540    1975     2110      1710
IN     25     -16        0       0        0     980     620     430      310       280
IN     25     -21        0       0        0     265     360    1120
IN     25     -24        0       0        4    1400
C
QA     25     -15        0       0        0    1250    1000     750
EJ
```

Uses of the Abbreviated Format:

1. Can be used to specify fewer than "NPER" (BF.2) time periods (useful for QA Records).

2. Can be used to specify record values that require more than six digits including the decimal point (field 1 of standard format provides only 6 digits of information).

3. Is used by HEC-DSS to preserve accuracy when reading flow data from HEC-DSS into HEC-5.

G.12.1 IN Record - Inflows or Local Flows (required)

Flow data for NPER (BF.2) periods of IPER (BF.7) hours/min. duration starting on the date indicated by FLDAT (BF.5). **Type of flow** (e.g. local incremental, observed, or natural) is denoted by ILOCAL (J3.6) and INFLOW (J3.8). Flow units (m^3/s or ft^3/s) are specified by METRIC (J1.1).

Field	Variable	Value	Description
		First	*IN Record in a Time Series Sequence*
1	LOC	+	Location identification number (CP Record, field 1).
2			Not used.
3	CNSTIN	0	Flow values on IN Records will not be adjusted.
		+	Multiplier to adjust flow values for this location (LOC).
4-10			Not used.
		Second *and* ***Subsequent***	*IN Records in a Time Series Sequence*
1-10	QII(I,M)	+ or -	Values are **incremental** local flows if ILOCAL (J3.6) = 1. Values are **cumulative** observed (gaged) flows if ILOCAL=10 or =15. Values are **natural** flows if ILOCAL=20 or =25.

G.12.2 QA Record - User Specified Reservoir Releases (optional)

User specified reservoir **releases** (m^3/s or ft^3/s) and operation **codes** which override rule-based reservoir release decisions determined by HEC-5. Same input format as IN Records. Abbreviated format is particularly useful for QA data input.

Field	Variable	Value	Description
	First *QA Record in a Time Series Sequence*		
1	LOC	+	Location identification number (RL Record, field 1)
2-10			Not used.
	Second *and* ***Subsequent*** *QA Records in a Time Series Sequence*		
1-10	QA(I,M)	0	Program will determine release
		0.001	Release = 0.0 will be made.
		+ Flows[1]	Release = **QA** will be made for **current period only**. (Special code = 0).
		+ Y.Code	Special codes on following page allow user to specify controlling type of release for **current period only** (i.e., .01 repeats previous release, etc.). Codes for QA Records only include inflow (.41) plus codes .22 to Y.5 described on next page.
		- Flows	Release = **-QA** will be made starting with current period and continuing until changed by QA Record criteria for a later time period.
		- Y.Code	Special codes (-QA) allow user to specify controlling type of release starting with current period and continuing until changed by QA Record criteria for a later time period.

Special Codes[2]	Description
.01	Value **repeats** previous period's value
.02	Value is based on **interpolation** between user specified values (not codes)
Y.03	Value equals previous period's value **plus Y percent**
Y.04	Value equals previous period's value **minus Y percent**
Y.10	Value equals previous period's value **plus Y**
Y.20	Value equals previous period's value **minus Y**

[1] When a QA sequence for a given location includes a **non-integer** value with an *invalid code* (**Y.X**, where X is "not" a valid code), then the entire sequence for that **location** will be treated as **flow** values instead of code values.

[2] Special Codes .01 - .20 are items of general use for reservoir releases (QA Records), channel capacities (CC Records), or top of conservation storages (ST Records). For the QA Record only, these codes (except .02) can reference a program determined release in addition to a user specified release on the QA Record.

Flood Control Release[3]

.22	Gate regulation **emergency** release
.24	Dam site operational **channel** capacity
.25	Maximum **outlet** capacity
.27	Rate of change - **rising** release
.28	Rate of change - **falling** release
.36	Release based on **downstream** flood control regulation
.41	Release = **Inflow**
.42	Release based on previous period's **gate** setting

Release to Reach User Specified Levels, etc.

Y.43	Release is based on reaching (at end of current period) **level** (Y) specified (example: 122.43 draws reservoir to level 1.22)
Y.44[4]	Release is based on reaching (at end of current period) **storage** (Y) specified (example: 10000.44 draws reservoir to storage 10,000 AF)
Y.45[4]	Release is based on reaching (at end of current period) **elevation** (Y) specified (example: 12201.45 draws reservoir to elevation 1220.1)

Release to Reach Fixed Storage Zones

.23	Release for top **flood** control pool
.26	Release for top **conservation** pool
.29	Release for top **buffer** pool
.30	Release for **Level 1** pool

Release to Meet Requirements

.35	Release based on reservoir low flow - **required** Q
.34	Release based on reservoir low flow - **desired** Q
.37	Release based on **downstream** low flow requirement
.31	Release based on at-site **firm energy** demand
.32	Release based on allocated **system power** energy

Release For Balancing Tandem Reservoirs

.33	Release based on **balancing** with equivalent level of downstream reservoir
Y.50	Release of this upstream tandem reservoir is set to minimum release if (1) the immediate downstream tandem reservoir (first reservoir for which this reservoir operates) is rising (during previous two periods) and (2) the release from the downstream tandem reservoir (for the previous period) is less than Y, unless emergency releases override.

[3] Codes .22 to .50 are applicable to QA Records only. If criteria specified by codes is not applicable or results in negative releases, program determined releases are made. Positive releases specified by criteria will always be made except where those releases exceed outlet capacity or discharge to reach level 1.

[4] Use of Abbreviated Time Series Format provides the ability to store large values using CONST = code and MULT with IREP = -999 (See description for Abbreviated Time Series Format, Section 12 before IN Record description).

G.12.3 NQ Record - Base Condition Flows (optional)

Base condition flows (normally **natural flows** but can be flows for an existing system). Natural flows will be computed and printed when these records are omitted and when FLONAT (J3.4) = -1.

Field	Variable	Value	Description
	First *NQ Record in a Time Series Sequence*		
1	LOC	+	Location identification number (CP Record, field 1).
2			Not used.
3	CNSTIN	0	Flow values on NQ Records will not be adjusted.
		+	Multiplier to adjust flow values for this location (LOC).
4-10			Not used.
	Second *and* ***Subsequent*** *NQ Records in a Time Series Sequence*		
1-10	QPREP(I,M)	+	Base condition flows in m^3/s (ft^3/s) used for printout purposes and for expected annual damage base flows. Provide NPER (BF.2) values.

G.12.4 MR Record - Minimum Desired Flows (optional)

Field	Variable	Value	Description
	First *MR Record in a Time Series Sequence*		
1	LOC	+	Location identification number (CP Record, field 1).
2			Not used.
3	CNSTIN	0	Flow values on MR Records will not be adjusted.
		+	Multiplier to adjust flow values for this location (LOC).
4-10			Not used.
	Second *and* ***Subsequent*** *MR Records in a Time Series Sequence*		
1-10	QMIN(I,M)	+	**Minimum desired flows** ("or" minimum **required** flows if CP.4 is **negative**) in m^3/s (ft^3/s) for control point LOC. Required flows will be operated for when reservoir is "below" Top of Buffer pool, LEVBUF(J1.6). Provide NPER (BF.2) values.

G.12.5 QD Record - Diversion Flows (optional)[1]

Field	Variable	Value	Description
	First *QD Record in a Time Series Sequence*		
1	LOC	+	Location identification number (CP Record, field 1).
2			Not used.
3	CNSTIN	0	Flow values on QD Records will not be adjusted.
		+	Multiplier to adjust flow values for this location (LOC).
4-10			Not used.
	Second *and* ***Subsequent*** *QD Records in a Time Series Sequence*		
1-10	DQ(I,M)	0,+,-	Diversion flows in m^3/s (ft^3/s). Provide NPER (BF.2) values.

[1] DR.7 must = -5 for location LOC in order to read this QD Record.

G.12.6 EL Record - Stages (optional)

Stages for **non-reservoir** location. These data can be used in the operation and displayed only if ILOCAL (J3.6) = 1.

Field	Variable	Value	Description
	First *EL Record in a Time Series Sequence*		
1	LOC	+	Location identification number (CP Record, field 1).
2			Not used.
	Second *and* ***Subsequent*** *EL Records in a Time Series Sequence*		
1-10	ELEV(I,M)	+	Stages in meters (feet). Only positive stages can be used. Provide NPER (BF.2) values.

G.12.7 EV Record - Evaporation Rates (optional)

Evaporation rates for **reservoir** location. Each rate will be multiplied by EVRTO (R2.3), if EVRTO is greater than zero.

Field	Variable	Value	Description
	First *EV Record in a Time Series Sequence*		
1	LOC	+	Reservoir identification number (RL Record, field 1).
2			Not used.
3	CNSTIN	0	Evaporation rates on EV Records will not be adjusted.
		+	Multiplier to adjust EV evaporation rates for this reservoir.
4-10			Not used.
	Second *and* ***Subsequent*** *EV Records in a Time Series Sequence*		
1-10	EVRATM(I,M)	0,+,-	Net evaporation (total evaporation minus precipitation) rate in millimeters (inches) over the reservoir area for each period. Provide NPER (BF.2) values.

G.12.8 PV Record - Hydropower Energy Requirements (optional)

Field	Variable	Value	Description
	First *PV Record in a Time Series Sequence*		
1	LOC	+	Reservoir identification number (RL.1 and P1.1).
2			Not used.
3	CNSTIN	0	Energy values on PV Records will not be adjusted.
		+	Multiplier to adjust PV energy values for this reservoir.
4-10			Not used.
	Second *and* ***Subsequent*** *PV Records in a Time Series Sequence*		
1-10	POWR(I,M)	+	At-site **energy requirements** in thousands kWh. These values will override any values on PR, PD, or PH Records for this reservoir. Provide NPER (BF.2) values.

G.12.9 CC Record - Specified Operational Channel Capacities (or Stages) (optional)

Specified non-damaging operational channel capacities. Non-zero values of channel capacity for any given time period will override the values of channel capacity that are based on the constant channel capacity (CP.2) or the seasonal CC Records (before the ED Record) for the same location. Special codes .01, .02, Y.03, Y.04, Y.10 and Y.20 can be used for the CC Records (as well as the ST and QA Records) as explained in the QA Record description. These codes allow an easy way to repeat, increase, decrease or interpolate values on these records. Provide NPER (BF.2) values.

Field	Variable	Value	Description
	First *CC Record in a Time Series Sequence*		
1	LOC	+	Location identification number (CP Record, field 1).
2-3			Not used.
4	FLAGFT	0	CC values are in flow units (m^3/s or ft^3/s).
		10	CC values are in **stage** units (meters or feet). Stage values will be converted to flows using this control point's QS and EL Records.
5-10			Not used.
	Second *and* ***Subsequent*** *CC Records in a Time Series Sequence*		
3+	CHCAP	0	Channel capacity for current time period will be the value previously defined by data records prior to ED Record (unless a negative code (repeat previous value) occurs for a previous time period).
		+	The CHCAP value, m^3/s (ft^3/s), will be used for location LOC for current time period **only**.
		"and/or"	
		+	Special codes (.01, .02, Y.03, Y.04, Y.10, Y.20) for current period **only**.

G.12.10 ST Record - Specified Reservoir Target Storages (optional)

Specified reservoir target storages which override RL Record storage values for Top of Conservation pool (for level LEVCON, J1.4) (bottom of the flood control space). Special codes .01, .02, Y.03, Y.04, Y.10 and Y.20 can be used for the ST Records (as well as CC and QA Records) as explained in the QA Record description. These codes allow an easy way to repeat, increase, decrease or interpolate values on these records. Provide NPER (BF.2) values.

Field	Variable	Value	Description
	First *ST Record in a Time Series Sequence*		
1	LOC	+	Reservoir identification number (RL Record, field 1).
2-10			Not used.
	Second *and* ***Subsequent*** *ST Records in a Time Series Sequence*		
1-10	STCON	+	Storage for reservoir LOC for current time period **only** for level LEVCON, in 1000 m^3 (acre-feet).
		"and/or"	
		+	Special codes (.01, .02, Y.03, Y.04, Y.10, Y.20) for current period **only**.

G.13 End of Time Series Data

G.13.1 EJ Record - End of Time Series Data (required)

Record read after last record for each time series data set (defined as data between BF and **EJ** Records).

Field	Variable	Value	Description
1-10			Not used.

G.13.2 Start New Time Series or Job, or End All Data

Enter next set of flow data (records BF - EJ); **or** begin next job (T1-EJ) with T1 record, **or** use **ER** Record after last job.[1]

G.13.3 ER Record - End of All Data (Run) (required)

Record read to terminate the run after last time series of last job is read. Program will end with an ER Record.

Field	Variable	Value	Description
1-10			Not used.

[1] Up to 80 events (BF - EJ) may be read, and an unlimited number of jobs (T1 - EJ) may be used unless FC or SS Records are used. When FC and SS Records are used, a maximum of 25 jobs may be read.